25-10-95
M 50
57 PCB SERVICE
56 PHONE NOS
62

ENTERTAINMENT · AUTOMOTIVE · SPACE · INTERNET

No. 96

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ELECTRONICS

The Maplin Magazine

Britain's Best Selling Electronics Magazine

DECEMBER 1995 · £2.25

Printed in the United Kingdom

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Video Kaleidoscope project – create stunning psychedelic patterns on your TV screen

Planetarium competition

See page 8 for details

Build a fun-packed Voice Modulator project

All this and much much more!

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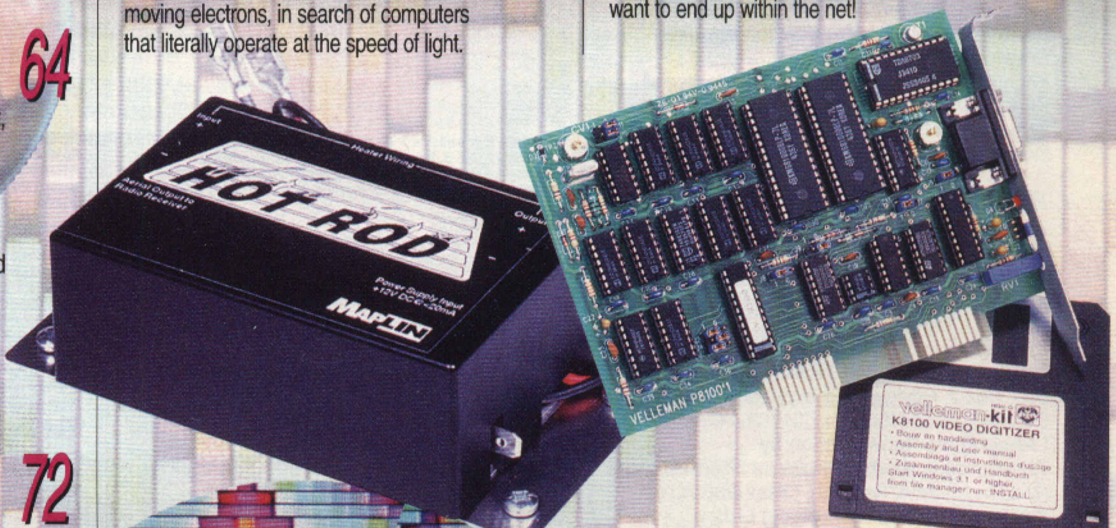
DECEMBER 1995
VOL 15. No. 96

IN THIS ISSUE...

PROJECTS *FOR YOU TO BUILD!*

FEATURES *ESSENTIAL READING!*



REGULARS *NOT TO BE MISSED!*

ABOUT THIS ISSUE . . .

Hello and Seasons Greetings to all our readers! Welcome to this month's issue of *Electronics*, I hope that you will find the selection of projects and features to your liking.

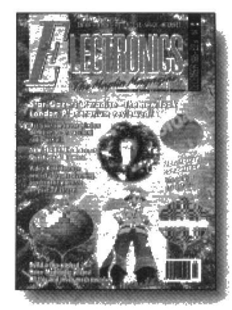
The *Electronics* Editorial team managed to tear themselves away from their word-processors to run the stand at Southend Radio Club's 75th Anniversary Rally. This went very well, with an impressive turnout, especially considering the poor weather that day.

The biggest, brightest and most notable event, and where we had our largest stand ever, was LIVE '95 at Earls Court. Fortunately for us, this was run by ever-enthusiastic staff from various Maplin stores around the country – (their considerable efforts were much appreciated by all) setting up and running a stand at a busy event is extremely hard work, and there were a total of 190,000 visitors over the six days that the event was held!

Some interesting statistics were provided by the Live show PR team, declaring that the worldwide consumer electronics industry is now worth £71 billion, which is predicted to rise to £80 billion by the year 2000. The UK market makes up for £3·5 billion (around 5%) of this total, and as such, is the world's fifth largest market in consumer electronics. Additionally, the percentage of British households owning PCs is now higher than any other European country, at 11·5% against Germany's 8·7%. It seems that even this figure will be likely to rise sharply over the next few years, as interest in the Internet and other aspects of the information superhighway take off. In fact, if you fancy a slice of the action, it's probably best to climb aboard the bandwagon right now, before it all gets too crowded!

So until next month, from the rest of the team and myself, enjoy this issue, have a Merry Christmas, and a Happy New Year!

Two of the team on The *Electronics* stand at the Cliffs Pavilion, Westcliff.



Merry Christmas to all our readers!

EDITORIAL

Editor Robin Hall FBIS, G4DVJ
Technical Authors Maurice Hunt BSc (Hons), Mike Holmes.
Print Co-ordinators John Craddock, Len Carpenter
News Editor Stephen Waddington BEng (Hons)
Drawing Office Ross Nisbet
Technical Illustrators Paul Evans, Nicola Hull, Kevin Kirwan Dip.Comp.
Project Development Chris Barlow, Dennis Butcher, Alan Williamson, Nigel Skeels

PRODUCTION

Art Director Peter Blackmore
Production Controller Jason Hyatt
Designers Jim Bowler, Matt Buhler
Layout Artists Tracey Walker, Adrian Dulwich, David Holt, Daniel Drake.
Photography Co-ordinator Tracy Swann
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MANAGEMENT

Senior Manager Design and Publications Steve Drake
Publications Manager Roy Smith
Development Manager Tony Bricknell

ADVERTISING

Jackson-Rudd & Associates Ltd., 2 Luke Street, London, EC21 4NT. Tel: (0171) 613 0717. Fax: (0171) 613 1108.
Advertisement Manager Eric Richardson.

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Project Ratings

Projects presented in this issue are rated on a 1 to 5 for ease or difficulty of construction to help you decide whether it is within your construction capabilities before you undertake the project. The ratings are as follows:

1 Simple to build and understand and suitable for absolute beginners. Basic of tools required (e.g., soldering iron, side cutters, pliers, wire strippers and screwdriver). Test gear not required and no setting-up needed.

2 Easy to build, but not suitable for absolute beginners. Some test gear (e.g., multimeter) may be required, and may also need setting-up or testing.

3 Average. Some skill in construction or more extensive setting-up required.

4 Advanced. Fairly high level of skill in construction, specialised test gear or setting-up may be required.

5 Complex. High level of skill in construction, specialised test gear may be required. Construction may involve complex wiring. Recommended for skilled constructors only.

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Kits, components and products stocked by Maplin can be easily obtained in a number of ways:

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Prices of products and services available from Maplin, shown in this issue, include VAT at 17·5% (except items marked NV which are rated at 0%) and are valid between 20th October 1995 and 30th November 1995 errors and omissions excluded. Prices shown do not include mail order postage and handling charges, which are levied at the current rates indicated on the Order Coupon in this issue.

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If you have a technical enquiry relating to Maplin projects, components and products featured in *Electronics*, the Customer Technical Services Department may be able to help. You can obtain help in several ways; over the phone, Tel: (01702) 556001 between 9.00am and 5.30pm Monday to Friday, except public holidays; by sending a facsimile, Fax: (01702) 553935; or by writing to: Customer Technical Services, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Don't forget to include a stamped self-addressed envelope if you want a written reply! Customer Technical Services are unable to answer enquiries relating to third-party products or components which are not stocked by Maplin.

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If you get completely stuck with your project and you are unable to get it working, take advantage of the Maplin 'Get You Working' Service. This service is available for all Maplin kits and projects with the exception of: 'Data Files'; projects not built on Maplin ready etched PCBs; projects built with the majority of components not supplied by Maplin; Circuit Maker ideas; Mini Circuits or other similar 'building block' and 'application' circuits. To take advantage of the service, return the complete kit to: Returns Department, Maplin Electronics plc., P.O. Box 3, Rayleigh, Essex, SS6 8LR. Enclose a cheque or Postal Order based on the price of the kit as shown in the table below (minimum £17). If the fault is due to any error on our part, the project will be repaired free of charge. If the fault is due to any error on your part, you will be charged the standard servicing cost plus parts.

Kit Retail Price	Standard Servicing Cost
up to £24.99	£17.00
£25.00 to £39.99	£24.00
£40.00 to £59.99	£30.00
£60.00 to £79.99	£40.00
£80.00 to £99.99	£50.00
£100.00 to £149.99	£60.00
Over £150.00	£60.00 minimum

Readers Letters

We very much regret that the editorial team are unable to answer technical queries of any kind, however, we are very pleased to receive your comments about *Electronics* and suggestions for projects, features, series, etc. Due to the sheer volume of letters received, we are unfortunately unable to reply to every letter, however, every letter is read – your time and opinion is greatly appreciated. Letters of particular interest and significance may be published at the Editors discretion. Any correspondence not intended for publication must be clearly marked as such.

Write to: The Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex, SS6 8LR, or send an e-mail to AYV@maplin.demon.co.uk

1

STARS SHINE at the NEW-LOOK PLANETARIUM

by Alan Simpson

An abundance of stars in your eyes can be guaranteed for all visitors to the new London Planetarium. However, the stars on show are not Kim Basinger or Sharon Stone, but are more celestial – the event has the ability to project over 9,000 stars. At a cost of some £4·5 million, the newly refurbished Planetarium provides an exciting journey into cyber-space.

As the organisers point out, a planetarium may be one of two things. Its original meaning was an instrument for demonstrating the movements of the planets around the sun. Such working models were known to the ancient Greeks 2,000 years ago. A planetarium is also a building in which the night sky is accurately portrayed. The first large scale instrument to simulate the whole sky, including stars, in an accurate way, was not developed until early in the 20th century, by Dr Walter Bauersfeld, an engineer working for the German optical firm, Carl Zeiss. In 1926, his star projector was installed in the very first planetarium building in Munich.

London had to wait until 1958 for its first large-scale planetarium to be opened. This replaced the bomb-damaged Madame Tussaud's cinema, and the building, which featured a large dome constructed from concrete, created considerable interest. Concrete ribs supported the outer copper dome, which is now a familiar London landmark, while many inner layers separate the artificial sky inside from the noise of the outside world. Incidently, when the model Saturn was fixed to the top of the dome, it acquired the name of 'Britain's first Sputnik', after the very first spacecraft launched in 1957.

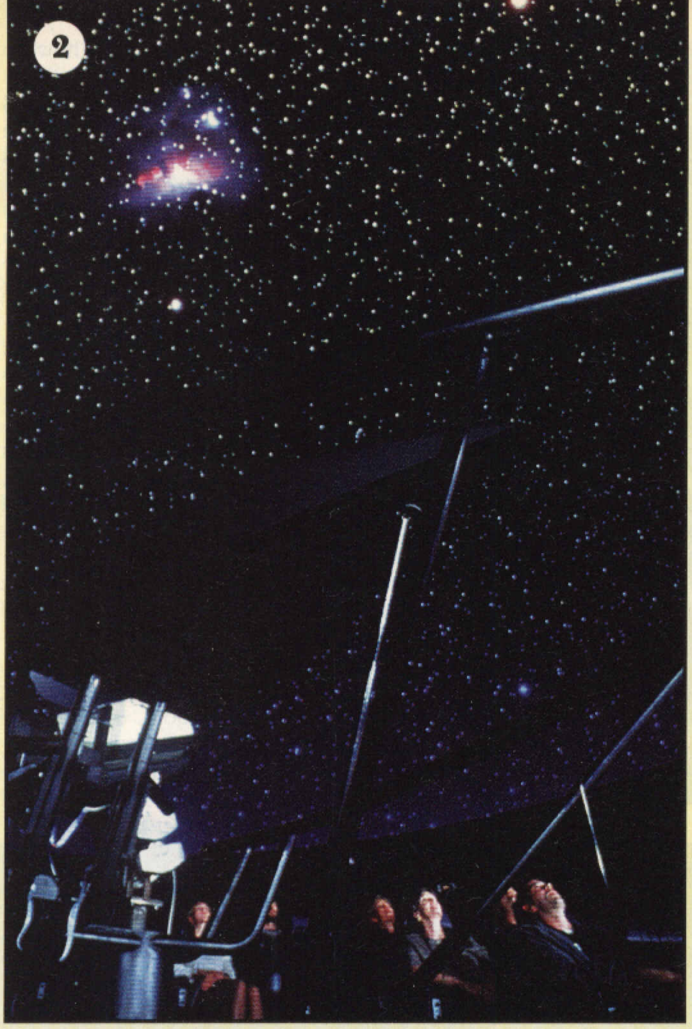
The Vision

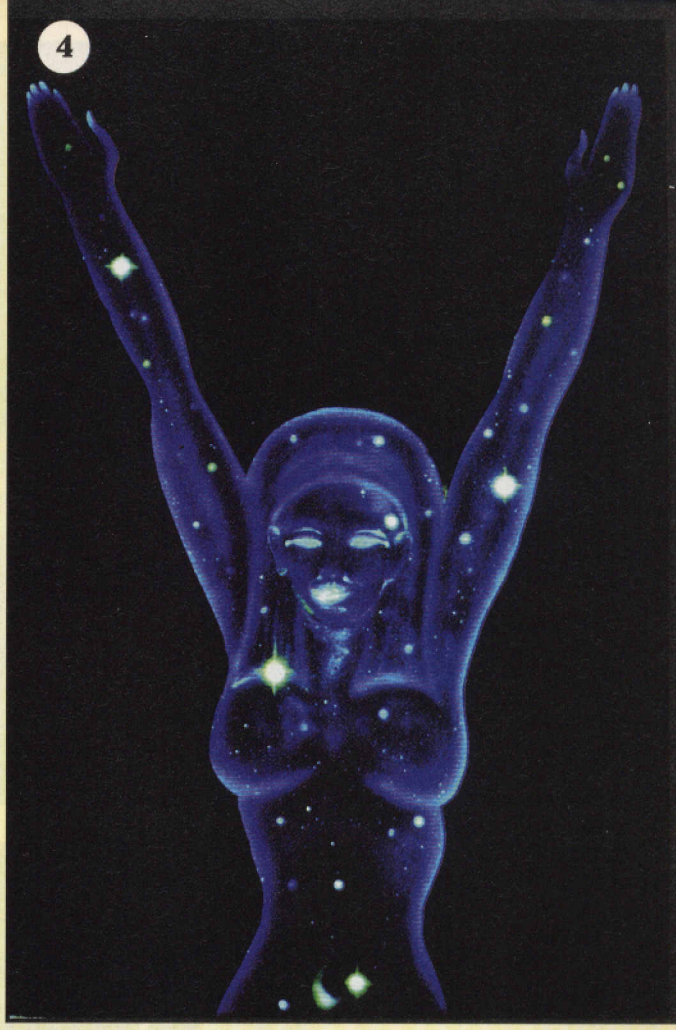
For almost 40 years, the original London Planetarium, within the Madame Tussaud's waxworks in Marylebone Road, has served the public well. As Chris Gutteridge, senior audio/visual technician pointed out, the building was beginning to show its age, and a virtual relaunch was becoming essential.

During the winter of 1994/95, architects were commissioned to embark on a major renovation programme. This included a striking new entrance providing improved access, an extra floor and the seating reorientated to create a much more flexible space. For the first time, wheelchairs could be admitted directly to the auditorium. Photo 1 shows the inside of the new auditorium.

The new London Planetarium, the architects Fletcher Priest said, was a bit like putting a ship in a bottle – and it had to be built in 20 weeks, so closure of the Planetarium was as short as possible. At the heart of the redesign is the extraordinary Digistar II, which projects a 3-D computer model of the universe on the new suspended projection dome (see Photo 2). The seating arrangement has been totally redesigned to ensure each visitor's view is precisely targeted at the focal point of the dome, and enables each visitor to experience the dynamic effect of travelling through space. The auditorium sits on a sloping floor, which has been inserted above the original auditorium floor to make an extra level commented and create new exhibition and waiting space.

As Fletcher Priest commented, "the job was complex, because Madame Tussaud's continued to operate throughout the project.





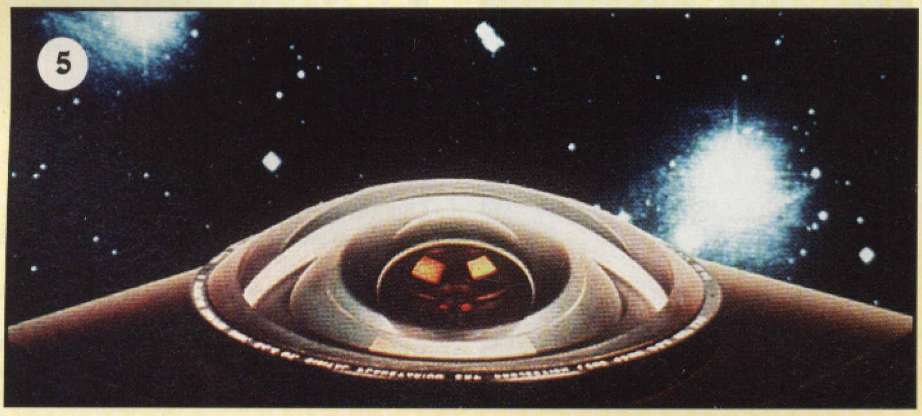


Photo 1. Inside the new auditorium.
Photo 2. The new Digistar II projecting the stars onto the dome of the London Planetarium, recently relaunched after a £4·5 million transformation.
Photo 3. The Digistar II projection system.
Photo 4. Nut, the Egyptian goddess of the sky – part of the new Cosmic Perceptions show at the London Planetarium.
Photo 5. An image from the new Cosmic Perceptions show at the London Planetarium.

Beneath the site is the Dark Ride, round the sides of the site is the exhibition area and outside, on the street, the inevitable queue. Underneath the Dark Ride are six London Underground lines, so putting in foundations for the new auditorium floor presented some difficulties. A series of piles, reached by tunnels, were sunk below the Dark Ride. Getting materials on and off the site presented further problems, so demolition rubble and building materials all went through a couple of door-size slots in the dome – more reminiscent of key-hole surgery than a conventional building project."

Thanks to all this inspired work, visitors can move through the exhibition area to the theatre-styled auditorium at their own pace, and after they have seen the show, they can walk straight through to Madame Tussaud's. The entry process is designed to adjust eyesight from daylight to the low lighting required for Planetarium projection.

Virtual Reality

The end result of the transformation, is the fact that the 36 year-old Zeiss Universal Star Projector finally came to the end of its very hardworking life. The new state-of-the-art Digistar II projection system, the first in Europe and costing some £500,000, produces

conventional stars and planets of the night-sky and makes use of computer graphics to bring virtual reality to a three-dimensional journey through space, as shown in Photo 3. "Unlike mechanical projectors, which only give an Earth-based view of the heavens, Digistar II can transport you with complete accuracy through galaxies at the edge of the known universe, or can recreate the Big Bang, before which, nothing existed. It can also be used in non-astronomical contexts to create all kinds of exciting graphics: it is limited only by the confines of human imagination", says Undine Concannon, the Planetarium administrator. "It can set you right among the stars, well beyond the limits of the Solar System. It can even plunge you into a black hole, but still allow you to emerge, shaken, stirred, but alive. Thanks to the sound system, which can transmit music around the audience in three dimensions, plus a comprehensive array of slide and video projectors and computers, audiences can be entertained and educated at a stroke of light."

The Black Hole Experience

The Digistar equipment which was first installed in Utah, USA, was originally designed as a database of stars for NASA, the United States space agency. Here, it helps astronauts get acclimatised to viewing familiar stars and constellations from unfamiliar angles. In London, it is the centrepiece for the Planetarium's new 'Cosmic Perceptions' show, which provides visitors with a virtual reality tour, ranging from deepest space to the human body, as it demonstrates how we perceive light. The system, designed by Evans & Sutherland Computer Corporation, starts the journey with sunrise over Stonehenge and voyages through superclusters, galaxies and other space phenomena (see Photo 4). The show includes an 'inner space' journey down the optic nerve to the human eye, to show how the brain interprets what the eye sees. Combined with a new surround-sound system and specially composed music, 'Cosmic Perceptions' is the most thrilling example yet of the new breed of planetarium shows, which combine science and entertainment into a universally enjoyable programme. With over twelve of the systems on order for planetarium sites round the world, many millions will have the opportunity of experiencing the enjoyment, said the suppliers (see Photo 5).

Digistar II incorporates both the scientific accuracy of a traditional star projector and the visual stimulation of a virtual reality environment, to create an immersive system. The compact design eliminates the need for a separate computer room, and is small enough for the projector, operator workstation and graphics to fit unobtrusively inside the theatre. The system can graphically project 3-D images, including molecular models, architectural renderings of buildings or cities and fractal images, thereby expanding its use far beyond astronomy.

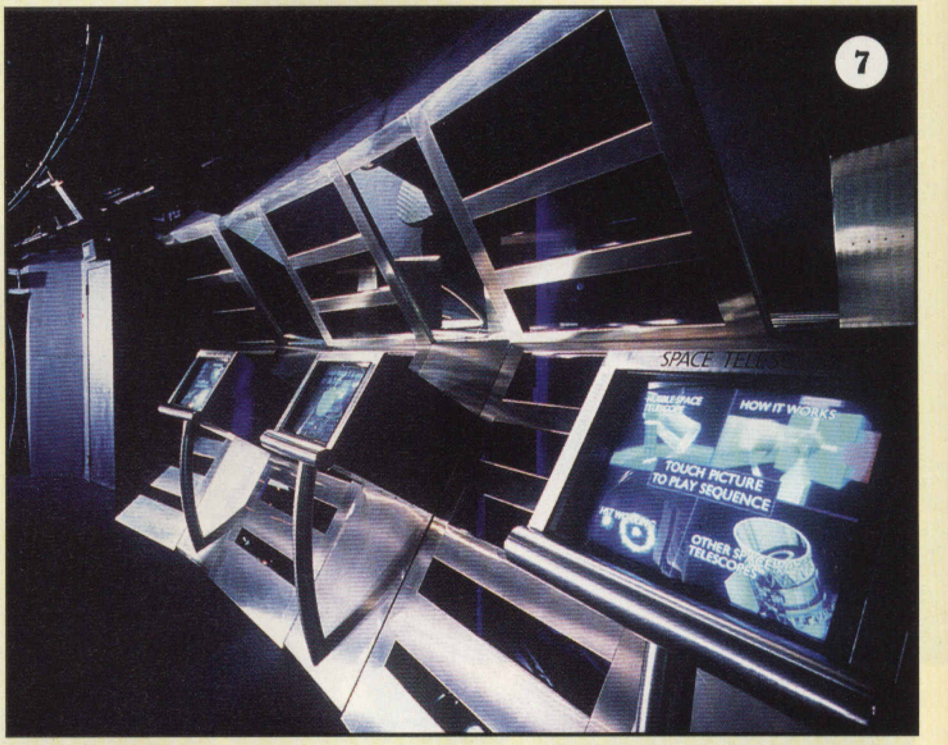


Photo 6. Planet Zone – one of three interactive exhibition areas at the new London Planetarium, relaunched in June 1995 after a £4·5 million transformation.
Photo 7. Space Zone – one of three interactive exhibition areas at the newly transformed London Planetarium.
Photo 8. The wax figure of Professor Stephen Hawking – one of the exhibits in the interactive Space Zone exhibition area at the Planetarium.

Tripping through Space

The new theatre auditorium holds 393 people, with fresh performances held every 40 minutes. However, with the new system and seating layout, everyone gets the same view of the stars, together with a sensation of weightless suspension simulated in the auditorium. Outside, there are three levels of interactive exhibition areas – Launch Zone, Planet Zone (shown in Photo 6) and Space Zone (Photo 7). Here, little-known facts are revealed about our nearest neighbours in the solar system. Here also, you can hear a model of Stephen Hawking talking about those mysterious and controversial black holes in outer space (see

Photo 8). Also present, are wax models of some of the most outstanding astronomers in history, giving a human dimension to the mass of information which is available on the interactive video screens. From Copernicus and Galileo, Isaac Newton, Edmond Halley and Einstein, they represent the milestones in our knowledge of the universe, while the first moon-walking astronauts, Armstrong and Aldin, represent a more physical advance into space. Visitors can also experience the delights of the gravity well, and experiment with the plasma ball light fittings.

Teaching the World

Considerable thought has been given to the exhibition facilities. Disabled access apart, there are special induction circuits for the hard of hearing. To assist understanding, visitors can obtain a headset and plug it into their seat sockets, in order to enjoy the commentary in a number of languages, including French, German, Spanish and Italian.

In addition to the regular public programme, and a weekly 'Sky this Week' talk, the Planetarium stages a range of regular programmes for school groups of all ages. In fact, the space programme has been geared on that part of the national curriculum which cannot be demonstrated in the classroom. Live presentations are also given for groups such as scouts and astronomical societies, and for those interested in Astro-Navigation, with celebrity events taking place from time-to-time.

Space Out at the Planetarium

You don't have to be an astronomy buff to enjoy the show. It is for anyone who desires adventure and excitement. The sheer scale and size of the universe fills one with considerable awe. The London Planetarium sends you on a veritable journey into space.

Entry prices (correct at the time of going to press) are: Adults: £4.75, Children: £2.95, Senior Citizens: £3.65, Family Ticket: £12.45. A visit to The London Planetarium can be combined with the adjoining Madame Tussaud's. For further information, Tel: (0171) 486 1121.

We could make you see stars!

Now, having read this article and hopefully with your astronomic appetite (as opposed to gastronomic!) suitably whetted, why not try your luck in our superb competition to win tickets to the New London Planetarium. See page 8 for details on how to enter, and the very best of luck to you! E

CORRIGENDA

ISSUE 92/AUGUST 1995

Multi-Strobe, page 38, the circuit diagram shows C10 22μF fitted the wrong way round, should be shown with positive towards ground, see drawing (below). The layout on the PCB is correct.

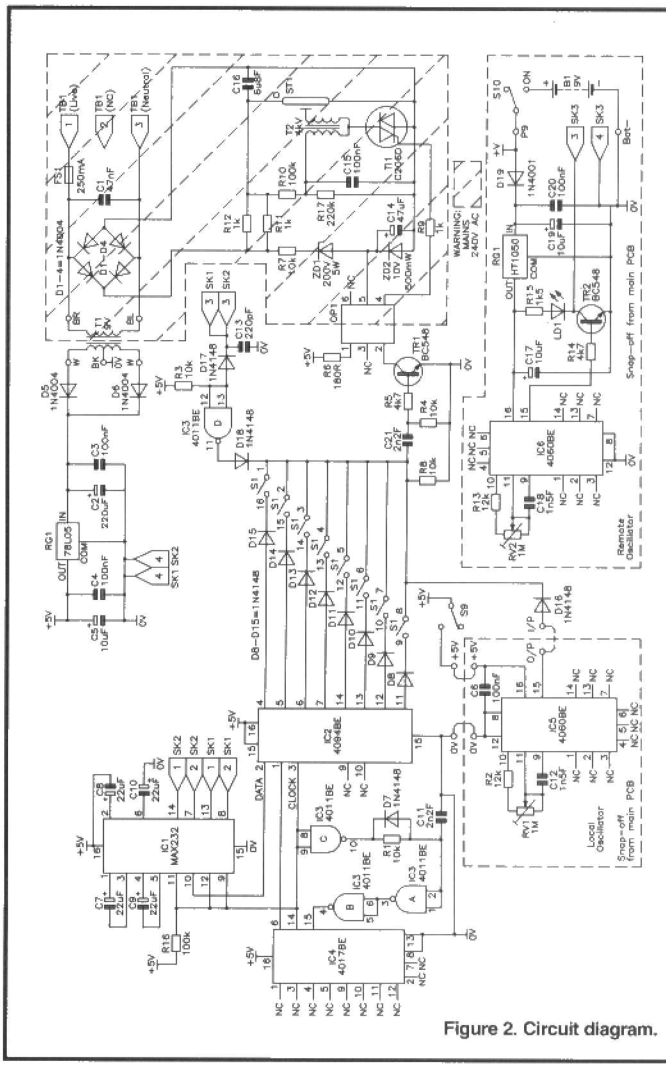


Figure 2. Circuit diagram.

ISSUE 95/ NOVEMBER 1995

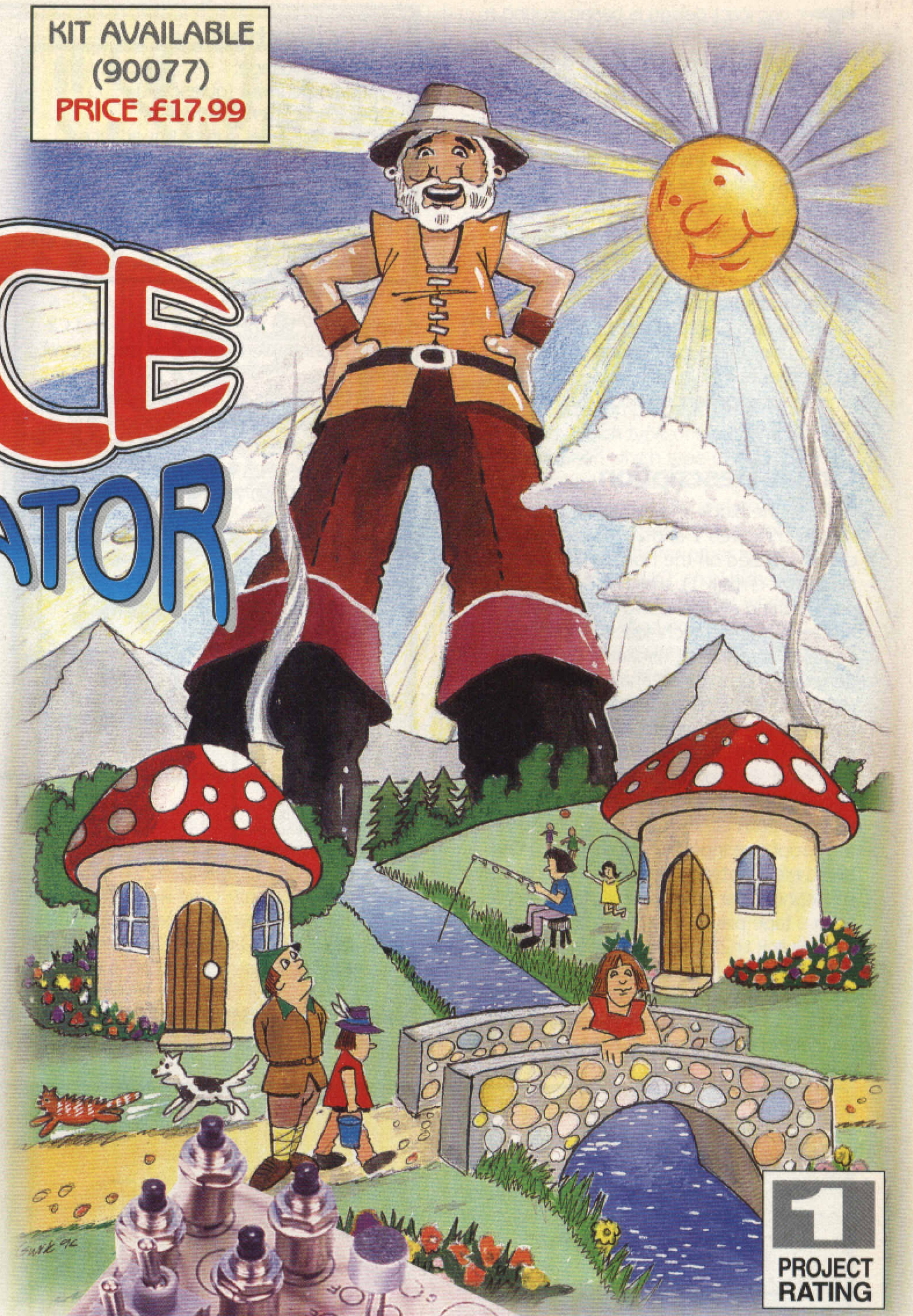
Door Chime, page 22, Parts List, Resistors should read:

R1	1k	1	(M1K)
R2	180k	1	(M180K)
R3	120k	1	(M120K)

Design by Alan Williamson
Text by Maurice Hunt and
Alan Williamson

**KIT AVAILABLE
(90077)
PRICE £17.99**

VOICE MODULATOR



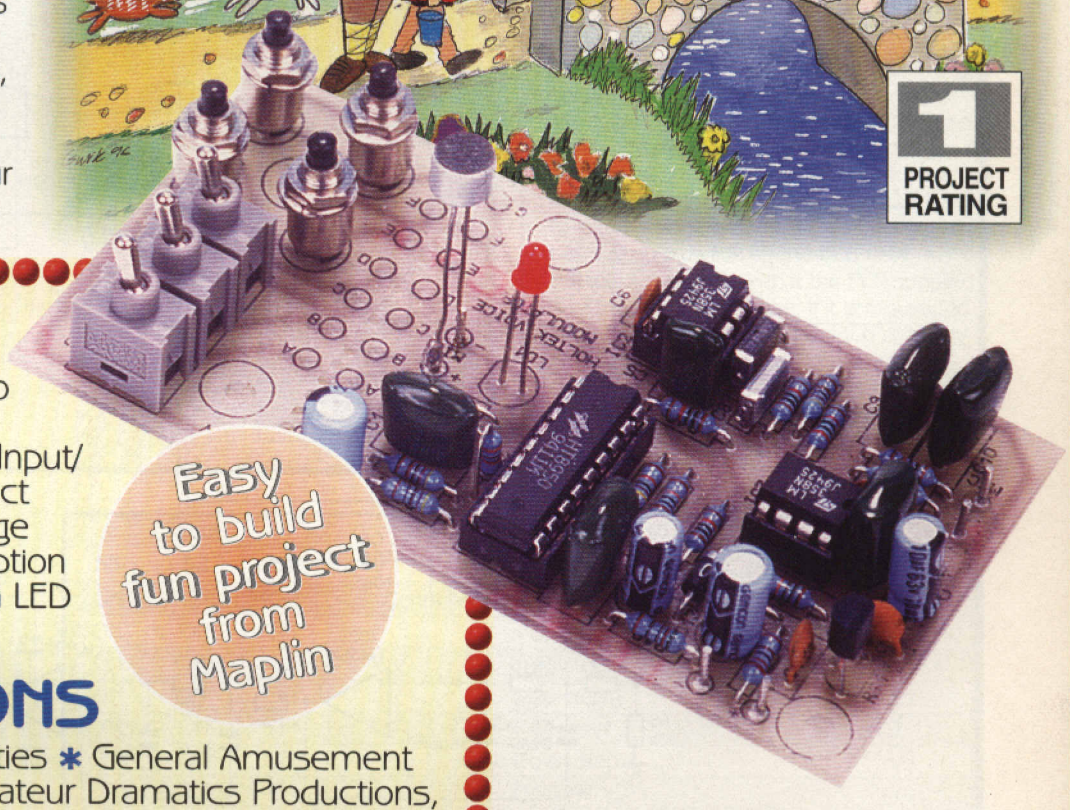
This superb, easy to build and use, novelty project provides a variety of voice modulation effects, including pitch level shifting and vibrato, to enable the effortless conversion of your voice, sourced from either a microphone or line level input, into a robotised, metallic sounding output. As well as the sheer amusement that this project will provide, it also has 'serious' uses, for example, to liven up childrens' toys, games and parties, or for use in theatre productions, or home videos, etc. Iln fact, the possible applications are almost endless if you put your mind to it!

FEATURES

* Robotised and Vibrato Effect Voice Modulation * Line and Microphone Input/Output Levels * Compact * Wide Operating Voltage * Low Current Consumption * Peak Input Modulation LED * Snap-off PCB Design

APPLICATIONS

* Toys, Games and Parties * General Amusement * Sound Effects for Amateur Dramatics Productions, School Plays, Home Videos, etc. * PA Systems



The assembled Voice Modulator PCB.

The compact design is based around a purpose-made voice modulator chip, which contains sophisticated digital signal processing circuitry for realistic and consistent sound effects. The circuit is very versatile, in that the inputs and outputs may be at either line or microphone (mic) level, with options of either on- or off-board microphones, and the project will operate from a wide operating voltage range, while also having a very miserly current consumption, meaning that it could be run for hours from a set of batteries. There are also plenty of switches to play with to tailor the output sound to your exact requirements – all in all, a very entertaining project, for experienced hobbyists and beginners alike!

Specification

Operating voltage:	5 to 12V DC
Operating current (quiescent):	4·1mA @ 5V, 4·5mA @ 12V
Operating current (activated):	6·5mA @ 5V, 6·8mA @ 12V (Maximum)
Microphone level output impedance:	4k2Ω
Microphone level 0dBV input:	20mV rms
Line level output impedance:	100kΩ
Line level 0dBV input:	775mV rms
PCB dimensions:	98 x 51mm
Visual indicators:	Peak input modulation LED

Circuit Description

Refer to the block and circuit diagrams shown in Figures 1 and 2, respectively. The circuit is based on the Holtek HT8950 Voice Modulator chip (IC1), which is basically a pitch-shifting device, using digital signal processing (DSP) techniques. This device contains an op amp, oscillator, timebase generator, comparator, analogue-to-digital (A/D) converter, static random access memory (S-RAM), a latch, and a digital-to-analogue (D/A) converter, in addition to control and power-on circuitry.

The input signal to the circuit may be sourced from either a line (0dB) input, or a microphone input, which may be an on-board electret type, an external condenser microphone, or other source, for example, from a tape player, etc. Resistors R1 and R2 (via link LK2b) serve as an input attenuator when the circuit is configured for line level input. For a microphone level input, R1 is replaced by a link, LK1. If using an electret microphone, R2 is used to supply power via the LK2a link. R5 and C2 provide a decoupled supply for the electret microphone.

The LED, LD1, is included to give a visual indication of peak input modulation, and is driven by the latch within IC1. R3 and R4 set the gain of IC1's internal inverting op amp to ×34·3 (30·7dB). R5 and R6 set the internal oscillator frequency, and therefore, the pitch ratios. The output signal of IC1 is passed through a 4-pole low-pass Chebyshev active filter, comprised of an LM358 op amp, IC2a and IC2b, plus associated components (R9-12, and C5-8). Note that the capacitor value in each section varies.

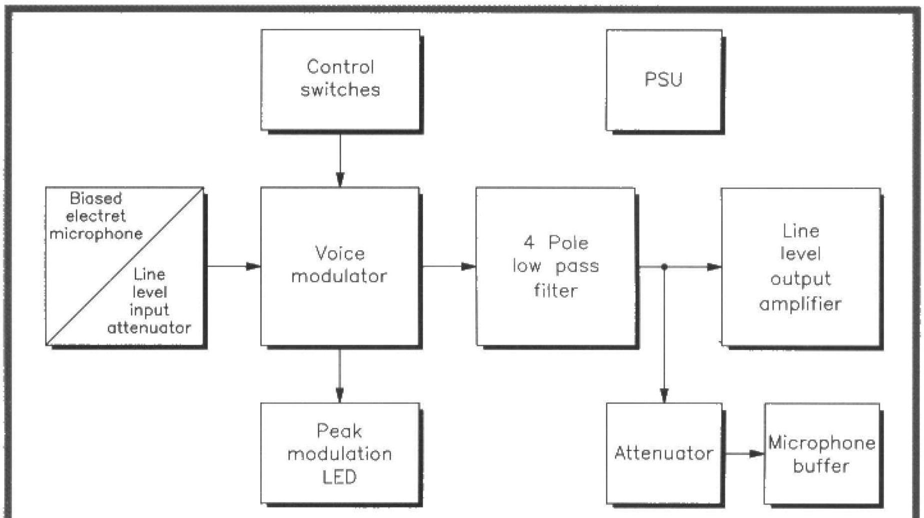


Figure 1. Block diagram of the Voice Modulator.

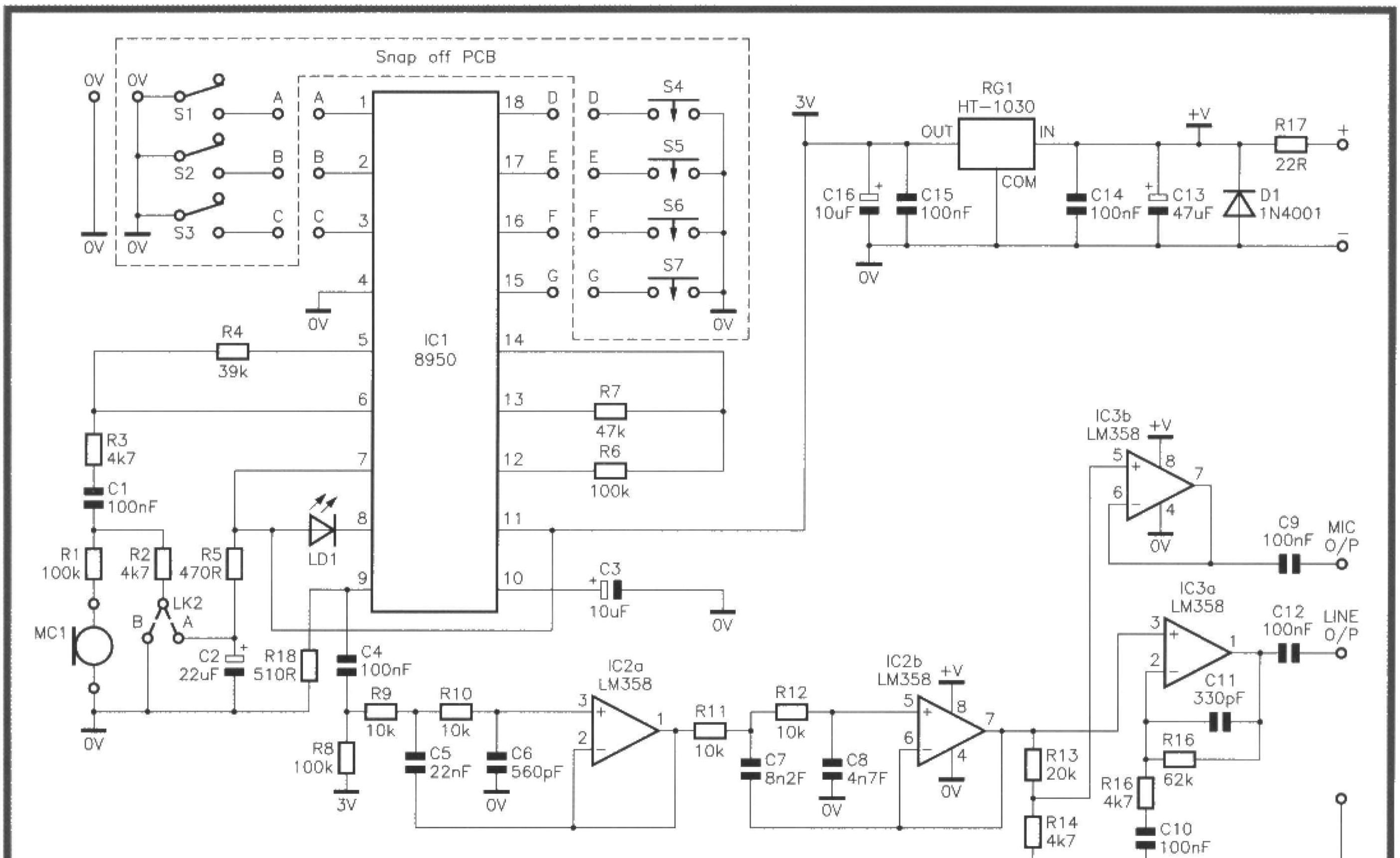


Figure 2. Circuit diagram of the Voice Modulator.

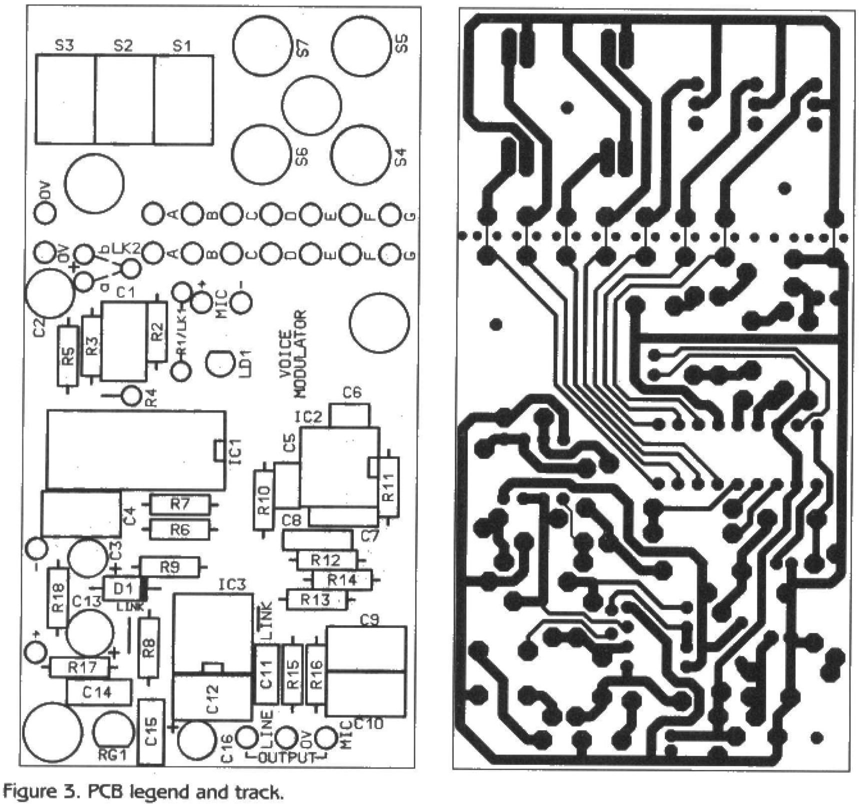


Figure 3. PCB legend and track.

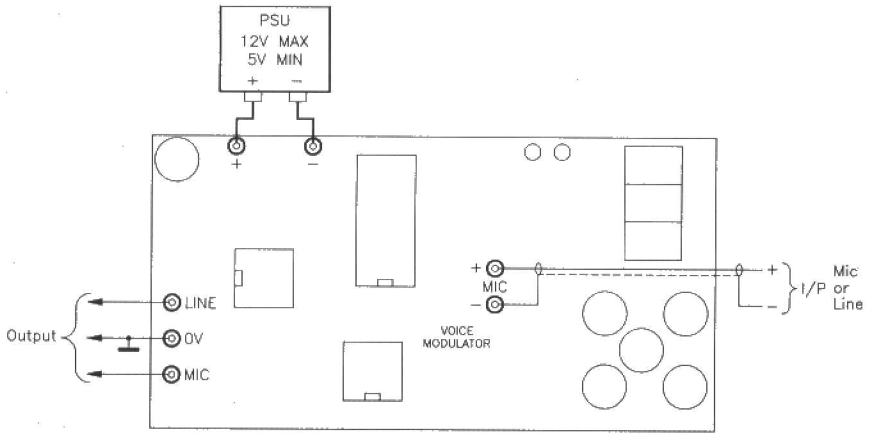
The function of this filter is to remove the high-frequency aliasing noise. Resistor R8 is required to set the DC bias of the op amps. IC3a provides the final amplification stage, up to line level, while R13 and R14 attenuate the signal to microphone level before being buffered by IC3b, which is in non-inverting voltage follower configuration (with a gain of 1, or 0dB).

Power to the circuit is provided by voltage regulator RG1, another Holtek device (HT-1030), which provides 3V DC. The input voltage range of the circuit is between 5 and 12V. Diode D1 serves as reverse polarity protection, with the reverse bias current limited by R17 (to around 0·5A with 12V applied) – this acts as a form of fuse in case of a reversed supply. R17 also acts in conjunction with C13 to provide a degree of filtering of the power supply. Capacitors C13 and C16, and C14 and C15 provide low- and high-frequency supply decoupling.

Toggle switches S1 to S3 control the pitch ratio, as per Table 1. Note that if S1, S2 and S3 are all in the ON (down) position, the pitch ratio will be controlled by the manual step push switches S5 (down) and S6 (up). However, with S1 and S2 ON, and S3 OFF, the circuit will be put into 'Normal' mode, whereby the output voice signal will be similar to the input voice signal (and at the same speed ratio, i.e., =1), with exception of some inevitable distortion caused by the digital sound processing circuitry.

Push switches S4 to S7 control the various operating modes provided by the circuit, as indicated in Table 2. Pushing S4 or S7 repeatedly will toggle the Robot or Vibrato mode on and off, respectively.

Figure 4. Wiring diagram.



Input			Step Mode	Speed Ratio
S3	S2	S1		
ON	ON	ON	Controlled by manual up/down switches	–
ON	ON	OFF	Up step 3	2
ON	OFF	ON	Up step 2	8/5
ON	OFF	OFF	Up step 1	4/3
OFF	ON	ON	Normal	1
OFF	ON	OFF	Down step 1	8/9
OFF	OFF	ON	Down step 2	4/5
OFF	OFF	OFF	Down step 3	2/3

Table 1. S1-3 position functions.

PCB Construction

Refer to Figure 3, showing the PCB legend and track, which will be of assistance during the build-up process. Determine beforehand, which type of input (line or mic) you require, and which type of microphone (if any) you wish to use. For a line level input, fit R1 and link LK2b, and omit C2 and R5. For the supplied electret microphone, fit links LK1 and LK2a; for other types of microphone, fit links LK1 and LK2b, and omit C2 and R5. Depending on whether R2 and link LK2b are fitted or not (i.e., Mic/Line inputs), the input impedance will be 4kΩ and 100kΩ, respectively.

The value of R2 could be altered to achieve the desired impedance for a particular microphone, for example, for an impedance (Z) of 600Ω, the value of R2 can be calculated in accordance with the formula:

$$R2 = \frac{1}{\left(\frac{1}{Z} - \frac{1}{R3}\right)} \text{ ; Where } R3 = 4k7\Omega$$

$$\therefore R2 = 687{\cdot}8\Omega$$

(Nearest prefered value = 680Ω)

Assembly of the board is fairly straightforward. Begin with the smallest components first, working up in size to the largest, and being careful to correctly orientate the polarised devices, such as electrolytic capacitors, diodes, voltage regulator, the LED and the microphone. Also ensure that the notches of the IC holders are correctly aligned as per the PCB legend.

The ICs should be inserted into their sockets last of all. Thoroughly check your work for misplaced components, solder whiskers, bridges, and dry joints. Finally, clean all surplus flux off the PCB using a suitable solvent. Note that the PCB supplied is of the 'snappable' type. If it is required to have the switch section mounted remotely of the main section of the board, score along the PCB tracks adjacent to the row of drilled holes, then carefully snap the two sections. Fit PCB pins along the row of holes along the edge of each board section,

and use 8-way ribbon cable (or individual wires) of the required length to interconnect the boards.

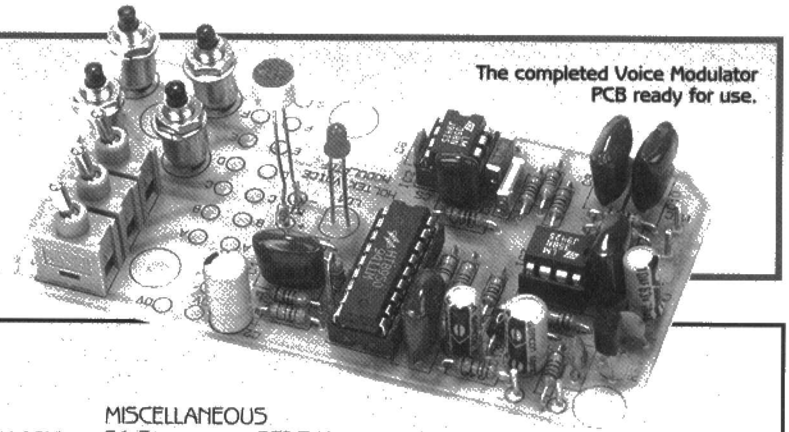
Testing and Use

Connect up the completed board as shown in the wiring diagram (see Figure 4). Connect the line- or mic-level output to a suitable amplifier (preferably via screened cable to minimise noise, and apply the power to the board, ensuring correct polarity. If running the circuit from batteries, ensure they are providing sufficient charge. Make sure at this stage, that none of the components are getting warm; if this occurs, switch off immediately and recheck your assembly work for mistakes.

If all is well, set the amplifier volume to the desired level, and apply an input signal; if using a microphone input, try speaking into it. You should hear a modulated (altered) version of the applied signal, and by altering the switch positions (refer to Tables 1 and 2 for a description of their functions), you should be able to achieve some interesting output sounds, including robotised, vibrato-effect and pitch-shifted voices. Have fun!

Switch	Operating Mode
S4	Robot (toggle)
S5	Downward step
S6	Upward step
S7	Vibrato (toggle)

Table 2. S4-7 position functions.



The completed Voice Modulator PCB ready for use.

VOICE MODULATOR PARTS LIST

RESISTORS: All 0·6W 1% Metal Film			
R1,6,8	100k	3	(M100K)
R2,3,14,16	4k7	4	(M4K7)
R4	39k	1	(M39K)
R5	470Ω	1	(M470R)
R7	47k	1	(M47K)
R9-12	10k	4	(M10K)
R13	20k	1	(M20K)
R15	62k	1	(M62K)
R17	22Ω	1	(M22R)
R18	510Ω	1	(M510R)
CAPACITORS			
C1,4,9,10,12	100nF Mylar Film	5	(WW21X)
C2	22µF 50V Radial Electrolytic	1	(JL12N)
C3,16	10µF 50V Radial Electrolytic	2	(FF04E)
C5	22nF Mylar Film	1	(WW19V)
C6	560pF Ceramic Disc	1	(WX65V)
C7	8n2F Polyester Layer	1	(WW28F)
C8	4n7F Polyester Layer	1	(WW26D)
C11	330pF Ceramic Disc	1	(WW62S)
C13	47µF 25V Radial Electrolytic	1	(FF08J)
C14,15	100nF 16V Ceramic Disc	2	(YR75S)
SEMICONDUCTORS			
D1	1N4001	1	(QL73Q)
LD1	3mm LED Red	1	(WL32K)
IC1	HT8950	1	(AE13P)
IC2,3	LM358N	2	(UJ34M)
RG1	HT1030	1	(GV11M)

MISCELLANEOUS			
S1-3	SPDT Miniature Vertical PCB Mounting Toggle Switch	3	(JX90X)
S4-7	Sub-miniature Push Switch Black	4	(JM01B)
MIC1	Sub-miniature Omni-directional Electret Microphone	1	(FS43W)
	8-pin DIL Socket	2	(BL17T)
	18-pin DIL Socket	1	(HQ76H)
	Single-ended PCB Pins 1mm	1 Pkt	(FL24B)
	PCB	1	(90078)
	Instruction Leaflet	1	(XV73Q)
	Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As 90077 (Voice Modulator) Price £17.99

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new item (which is included in the kit) is also available separately, but is not shown in the 1996 Maplin Catalogue.

Voice Modulator PCB **Order As 90078 Price £2.69**

TECHNOLOGY WATCH!

with Keith Brindley

As reported here in this very column last month, there were moves afoot to merge the two rival formats for digital video disc – *high-density multimedia compact disc* (HD-MCD) and *super-density digital video disc* (SD-DVD). HD-MCD is the format proposed by Sony and Philips, while SD-DVD is the one proposed by Toshiba, Hitachi, JVC, Matsushita, Mitsubishi, Thomson, Samsung, Zenith, and Uncle Tom Cobbley and all.

Well, as I said, the companies were finally managing to get together and talk, anxious not to create a situation similar to past headline competition between rival videocassette recorder systems, VHS and Betamax. The outcome is a joint standard, which can only be good news to consumers in the industry and home alike. As always, the Sony and Philips format looked set to be best for computer users, who require compatibility with existing CD-ROM drives and discs. On the other hand, home users (who have little regard for what's best for computers) were bound to appreciate the cheapness of the other alliance's format.

In reality, the two formats were just a bit apart when they got down to talking. Pun intended. Apparently, Sony and Philips were specifying that each 8-bit byte of data should have an extra eight bits added to it for error detection and correction (in a process known as 8/16 modulation), while the Toshiba alliance was specifying only seven extra bits (you've guessed it, 8/15 modulation). Compared with audio CDs with their 8/14 modulation, the difference is not as far apart as it would seem. It is the total number of bits on a disc which defines the capacity of it in terms of length of digital video film which can be stored, and a few minutes of motion picture time could be expected to be lost for the extra reliability which it would provide. Sony and Philips won the day as far as that's concerned, in that 8/16 modulation is used in the new standard, but the Toshiba alliance's physical disc structure is to be used. Discs with 133 minutes of playing time (as opposed to 142 minutes without the extra bit) are the result. In the end, with just a single format jointly developed by all involved, we should see the benefits of cheapness and compatibility, with a partnership rather than a war, sometime next year.

Hard Times

While discs (with a c) of the digital video kind look to be on the up, disks (with a k) appear to be suffering. While computer component parts prices (with the single exception of RAM memory modules) continue to fall generally, the prices of hard disk drives has fallen ever more dramatically over the last year or so. Where disk drives of 200M-bytes used to more than suffice the computer user a couple of years ago, 1G-byte and 2G-byte hard drives are commonplace in modern desktop computers, and that trend is set to continue, with prices for the same increase in capacity falling at a seemingly inverse rate. It is common to see large capacity hard drives going for just a £100 or so, whereas two years ago, they would have been far more expensive than the computer they are installed into.

But that means bad news for drive manufacturers around the world, and many of them are feeling the pinch. Put simply, if they can not ramp up cheap production of ever-higher capacity drives, they can probably kiss goodbye to their collective existence. Rodime, for example, currently earns much of its revenue from royalties generated through ownership of hard drive patents. That looks set to end, though, as the US Court of Appeals has upheld a ruling that one of Rodime's main patents is not valid. Quantum, who originally challenged the patent, will be significantly better off financially, not having to pay the royalties, and Rodime will be significantly worse off. Rodime has a similar claim against Seagate, and if it loses that battle too, will have to consider other options. Seagate, meanwhile, is in the process of merging with Conner, thereby reducing the numbers of drive manufacturers in a sweep.

What all this probably means is that prices falling at current rates cannot possibly be sustained. It is my bet that if you want to buy yourself a bigger hard drive, you should probably do so now. Prices surely cannot drop much further. Or can they?

Demobbing the Troops

Over the coming year or so, Mercury's One-2-One mobile telephone service is to be expanded to cover the whole of the country. Currently, One-2-One is available to just about 30% of the nation, mainly around its London base, but also in the West Midlands. Some £200 million is to be spent upgrading the system for national coverage, which is expected to be complete and operational by 1997.

Currently, One-2-One's main rival in the digital personal communications network (PCN) arena is Orange, which already covers some 70% of the population, but which also has plans for increased coverage.

On another front, however, the digital services offered by Vodafone and Cellnet are already available to over 95% of the nation. Aggressive pricing structures by Orange and One-2-One mean that if they can increase their coverage adequately, they will have an edge over the two other networks.

They have an edge technically, too. The higher operational frequencies of digital PCN means that individual transmission cells are smaller, which means that potentially more users can be on the network. Of course, smaller cell sizes also means that more base station transmitters have to be installed, in turn, meaning greater cost of infrastructure. However, the technology is such that Orange and One-2-One networks will probably form the basis of a global standard network in time. So, while the great majority of the country has to wait until Orange and One-2-One services become available (the PCN operators' mandates specify that 95% of the country must be covered by the year 2000) it will probably be worth the wait.

The opinions expressed by the author are not necessarily those of the publisher or the editor.

Stray Signals

by Point Contact

Thermionic Darlingtons

After PC's comments on Thermionic Darlingtons in the September issue he received a number of letters from readers, confirming the existence of such a device. PC came across it recently, under the title of the 'triple twin' valve, on page 36 of the second edition of *The Amateur Radio Handbook of 1941* (fourth printing), recently passed on to him by an elderly gentleman who had no further use for it.

W. G. H. W. of Hemel Hempstead, wrote in to say that he used two of them (6B5s) in push-pull configuration in the 1930s, and enclosed a base diagram of this valve's UX6 pin base, together with brief details of its ratings in both single-ended class A, and in push-pull. He still has one, and even offered it most kindly for PC to experiment with!

J. M. W. of Rayleigh, Essex (not far from the editorial offices!) added the information that there were two other types, a 6AC6 and a 2B6 (with a 2·5V heater), as well as the 6B5. He pointed out that the output triode section had a close-wound grid, and hence passed little current at zero bias. The valve was normally operated with a positive bias on the grid and capable of greater output than power pentodes of its day, at the expense of rather a thirst for heater current. Of course, the positive grid resulted in grid current, and this in turn, would result in high distortion if the grid were driven from a high source impedance, hence the in-built cathode follower.

H. W. R. of Swansea's letter included a photocopy of page V7 of the 1956 *A. R. R. L. Handbook*, showing a base diagram. He said the valve was capable of 12W or more output in push-pull from a 250V rail, but by the post-war era, it had been superseded by beam tetrodes such as the 6V6. His base diagram agreed with W. G. H. W.'s, in showing the cathode of the input triode/grid of the output triode strapped internally to the cathode of the output triode via a resistor. The purpose of this was presumably to augment and stabilise the anode current of the input triode, which otherwise would consist only of the grid current of the output section. Whether this resistor was accommodated within the glass envelope or within the valve base is not clear, but certainly the input section cathode/output section grid was not brought out to a separate pin, just like the input emitter/output base in a Darlington transistor. However, unlike a Darlington, the input section anode was brought out to a separate pin and returned direct to the H. T. rail.

Info, Please

In RF circuits, or even audio ones where very high gain is involved, it is sometimes necessary to add some local screening around one or more of the stages, in order to ensure stability. Where the screen has to be fabricated to a particular shape and then soldered into position, tin-plate salvaged from a tin-can can be very useful. PC always used to keep such a source of tin-plate handy in the laboratory, but alas, it has run out. The household rubbish still includes the occasional can, but nowadays, they always seem to have a corrugated section around the middle, quite spoiling them as a little tin-plate mine. Or else, they are made of aluminium instead, as in the case of 'tins' of cat food. If anyone knows of a product sold in tin cans with corrugation-free sides, PC would be grateful to hear from them, and happy to pass on the tip to readers.

Long Ring-mains

Stray Signals in the July issue, mentioned the steadily increasing use of solar energy in India, for things like water pumping, village power plants and lighting. Lighting? – but that is only required when the sun isn't shining, thus incurring the capital and maintenance costs of an energy storage system, such as lead-acid accumulators. The obvious solution, avoiding the need for energy storage, is a ring-mains around the equator. Each country's installed capacity for lighting would be connected to the ring-main during the hours of daylight, and its lighting load only during the hours of darkness. Clearly, to be useful, the ring-main would need to have a carrying capacity of many megawatts, which would imply a prohibitive cost in copper. PC hasn't done any sums on this, but it might be feasible using a supercooled cable, where the amount of copper needed would be much less.

A further thought: as things like water pumping can be done during the daylight hours, when solar electricity is available, the ring-main is needed solely for lighting. Perhaps a fibre-optic ring-main is the answer, with large parabolic mirrors tracking the sun feeding in energy in daylit countries, and pick-off points in countries where it is night. This avoids the inevitable inefficiencies associated with conversion of solar to electrical energy, and back again. Just how impractical it is depends upon the energy density that an opto fibre (of an unusually large cross-sectional area) can support. As the energy is broadband (incoherent) a low-loss fibre with no requirement for coherence can be used.

Lingua Franca

English (often of the American rather than the British variety) is the international language in many fields, not least, electronics. Indeed, at some foreign universities, the electronics degree courses are taught in English, so that fluency in the language is a prerequisite for registration. However, through the influence of education, television and other media, more and more people have a smattering of several European languages, even if no more than a few words. Perhaps the world will move towards an 'anything goes' sort of mongrel language. A typical snippet of conversation might be: "Es ist très chaud, no?" "Si, e really troppo hot!"

Yours sincerely,

Point Contact

The opinions expressed by the author are not necessarily those of the publisher or the editor.

KIT AVAILABLE (90073) PRICE £39.99 A1

2 PROJECT RATING

Design by Colin Bakewell
Technical support by Chris Barlow
Text by Colin Bakewell and Maurice Hunt

VIDEO KALEIDOSCOPE

Psychedelic patterns are very much the in-thing at the moment in videos for House, Rave, Hip-Hop and various other forms of music. If you watch Top of the Pops or MTV for a couple of tracks, you are sure to see at least one example of the current offering of swirling, pulsating and mutating imagery. Most of these patterns change in time with the rhythm of the music, and can greatly enhance the enjoyment of this type of music for its followers.

Please note the case shown is not included in the kit and must be purchased separately, if required.

The completed Video Kaleidoscope unit connected to a TV and Hi-Fi system.

FEATURES

- Built-in omni-directional microphone
- Direct stereo audio input
- Wide input signal range
- UHF or composite video output
- Large range of pattern selection, change rate and threshold levels
- Compact and easy to use

APPLICATIONS

- Discos
- Parties
- Raves
- Advertising/promotions
- General amusement
- Educational project

WARNING: Although the pattern change rates on the Video Kaleidoscope are limited to below 12Hz, its primary purpose to produce flashing patterns, may in some people (in particular those prone to epileptic seizures) produce unexpected side effects, such as dizziness and/or seizures. If you are affected, you are recommended not to use the unit in Auto or high manual rates. If you still experience problems, then do not use the unit at all.

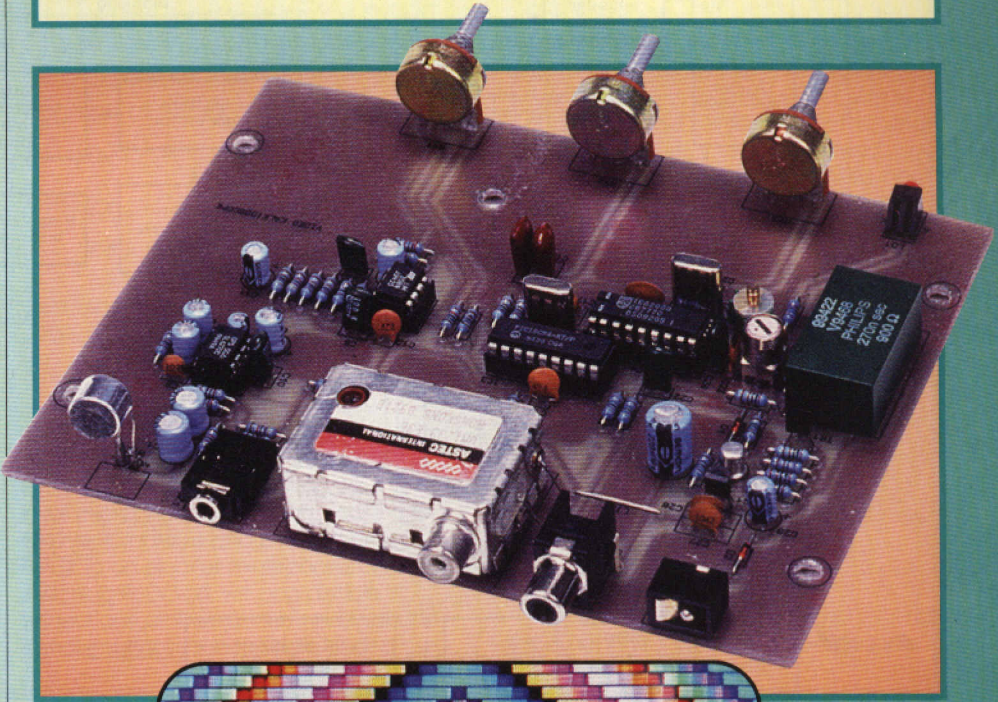
THIS is not a new phenomenon, sound-to-light systems have been used for years to create flashing coloured light in sympathy with the beat of the music. It is just that the new multi-coloured images and patterns can be so much more effective. The Video Kaleidoscope project gives everyone the ability to create these fascinating kaleidoscopic mosaic patterns on their own colour television.

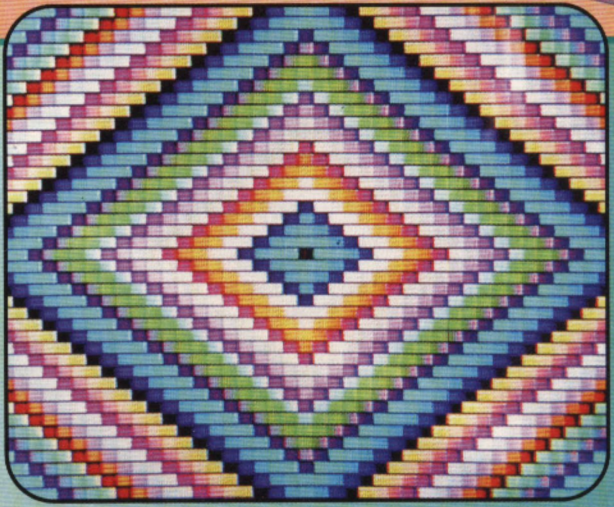
It is effectively an improved and updated version of the popular TVFX Unit, utilising a PIC microcontroller-based circuit, which offers a greater selection of patterns and effects. Using the built-in microphone, the patterns change in accordance with the beat of the music playing in the room or alternatively, the direct stereo audio input can be used to connect the Video Kaleidoscope to your Hi-Fi, CD or disco mixer. The Video Kaleidoscope accepts a wide range of sound and signal levels, due to the use of a sophisticated VOGAD IC.

There is a UHF output for connection to a standard (PAL) colour TV, and a 75Ω video output for connection to a video recorder, PAL colour monitor, video wall, or any SCART equipment via a suitable cable. The types of pattern and the way they change relative to the music can be adjusted by 'THRESHOLD' and 'MODE' controls on the front of the unit. The threshold setting effects the amount of change caused by each beat. A low setting causes the most and fastest changes, a high setting causes the least and slowest changes. For quiet music, a threshold setting too high can stop the pattern changes all together.

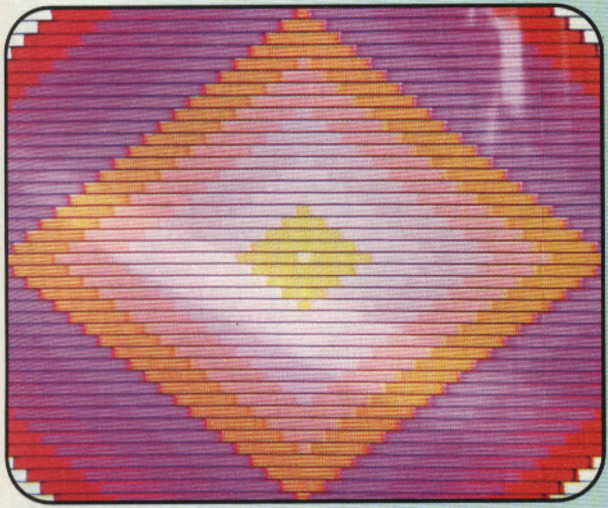
Specification

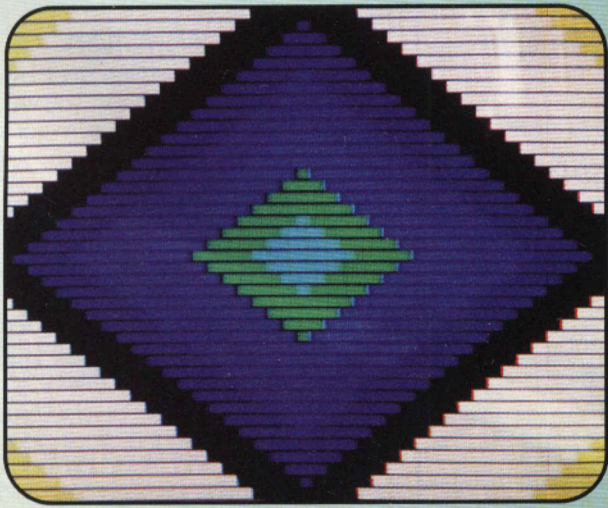
Supply voltage:	10 to13V DC (13·2V absolute maximum), via 2·5mm socket
Recommended power supply:	12V 300mA regulated
Supply current:	80mA @ 12V DC
Input impedance:	47kΩ
Input signal level:	20mV to 2V rms, via 3·5mm stereo jack socket
UHF output:	PAL colour TV, channel 36
Composite video output:	1V Pk-to-Pk, 75Ω impedance
Visual indicators:	Power on LED
Size:	175 × 130 × 58mm

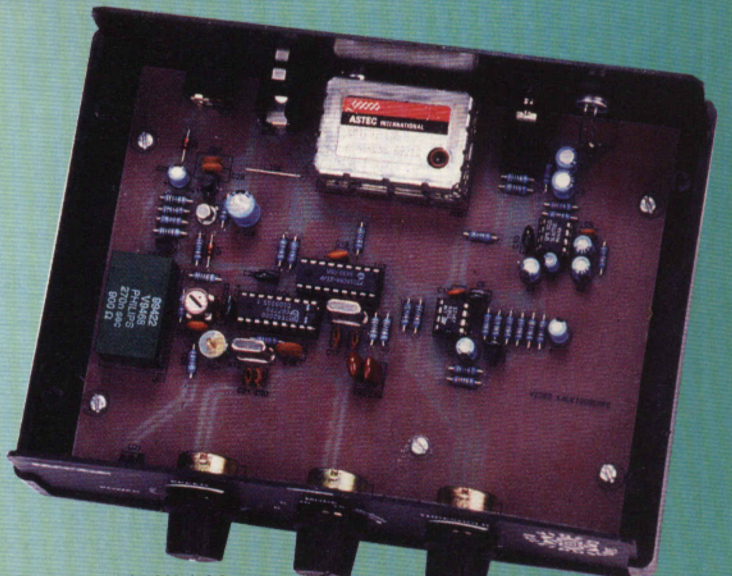




A selection of typical kaleidoscope patterns.







The assembled Kaleidoscope PCB mounted in Optional Box.

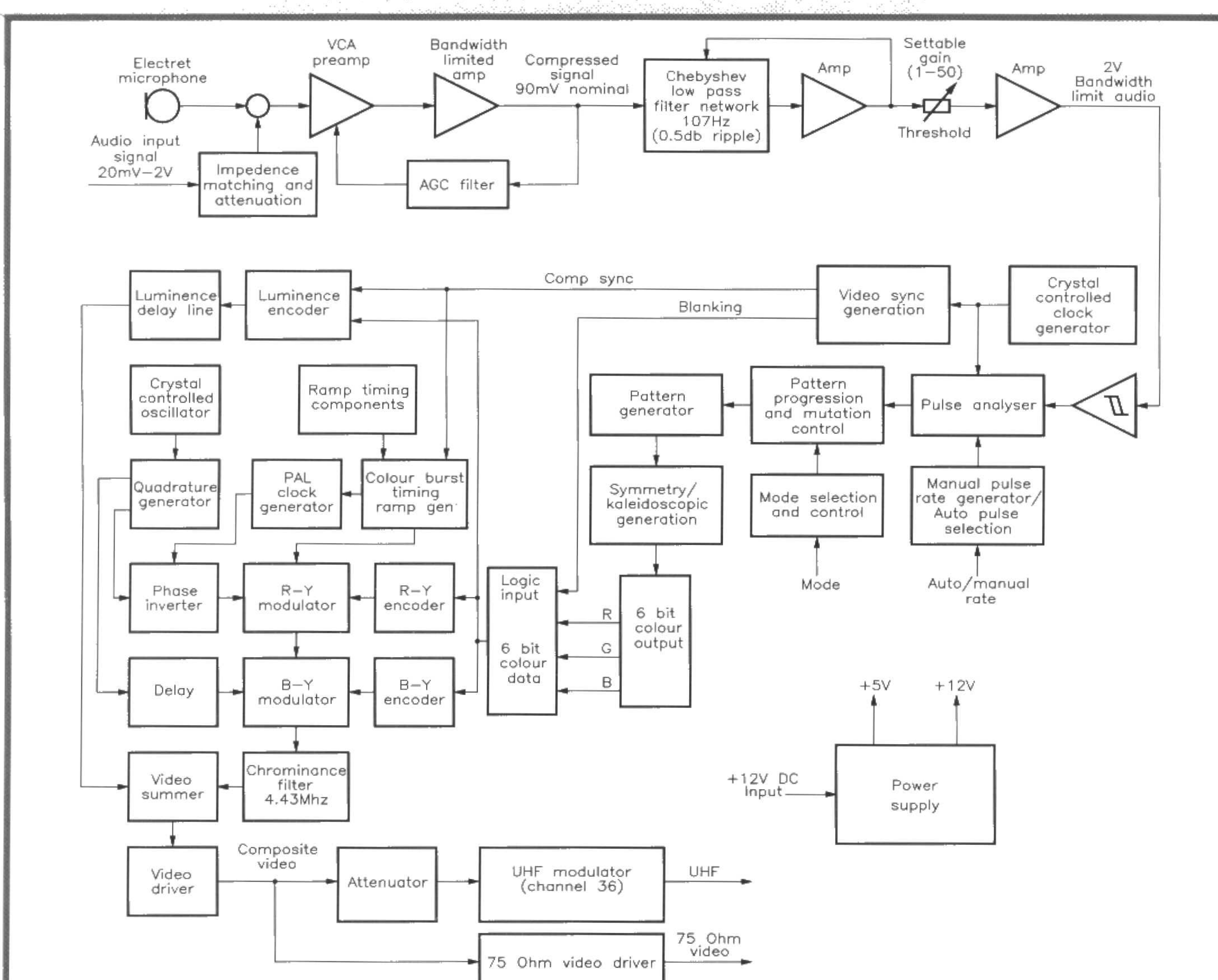


Figure 1. Block diagram of the Video Kaleidoscope.

The mode adjustment allows one of several pattern shapes, type and mutation law combinations to be selected shown in Table 1. The various modes are detailed later in the article. Also, there is the 'SPEED' control, which allows the unit to be wholly triggered by the beat of the music or to be triggered also at a manually set rate. This is useful to test the unit, and to provide a changing pattern when there is no music. If music is played into the Video Kaleidoscope when it has been set to a manual rate, the rate will 'phase lock' to the beat of the music, and this can generate some very interesting effects. The project is powered by a standard 12V regulated battery eliminator power supply unit via a 2·5mm power socket (centre pin positive).

The current mode is indicated by coloured blocks on far left of screen. Mode 0 is indicated by the block being vertically in the middle of the screen, higher modes are indicated by the block moving up the screen by one block per mode. Multiplexed modes are indicated by flashing blocks corresponding to each mode being multiplexed.

Mode	Description
0	Limited pattern changes on break, pattern progression on beat
1	Unlimited pattern changes on break, pattern progression on beat
2	Unlimited pattern changes on beat. Mutation laws A
3	Unlimited pattern changes on beat. Mutation laws B
4	Ghosted Diamond pattern progression on beat
5	Inwards diamond, progression on beat
6	Outwards diamond, progression on beat
7	Cross, progression on beat
8	Inwards circle, progression on beat
9	Outwards circle, progression on beat
10	Psychedelic Diamond, progression on beat
11	Semi-fixed Type A pattern 1, progression on beat, mutation on break
12	Semi-fixed Type B pattern 2, progression on beat
13	Cusp pattern, progression on beat
14	Semi-fixed Type A pattern 3, progression on beat, mutation on break
15	Semi-fixed Type B pattern 4, progression on beat, mutation on break
16	Multiplex modes 1 to15, change mode each beat
17	Multiplex modes 1 to 15, step by 2, change mode each beat
18	Multiplex modes 1 to 15, step by 3, change mode each beat
19	Multiplex modes 1 to 15, step by 4, change mode each beat
20	Multiplex modes 1 to 15, variable step size, change mode each beat

Table 1. Modes of Operation.

Circuit Description

If you look at Figure 1, the block diagram of the Video Kaleidoscope, you will see that the circuit consists of six major parts;

(i) The audio signal input, microphone and automatic gain control (VOGAD)
(ii) The low-pass active filter and threshold amplifier
(iii) The PIC16C54 microcontroller (the heart of the project)
(iv) The TEA2000 PAL colour modulator
(v) The UHF and video output
(vi) The power supply regulation

Each of these parts will be discussed in turn. Figure 2 shows the circuit diagram of the project, and should be read as referred to in the following description.

Audio Signal Input

There are six main elements of this part of the circuit to be described. The audio signal input is based around the SL6270CDP VOGAD IC. This chip is designed to produce a constant output signal for a wide range of input sound levels to a low impedance dynamic microphone connected across its differential inputs. This standard mode of operation has two drawbacks in this application:

(i) It does not allow for direct electrical connection to a signal source such as a Hi-Fi.
(ii) It does not allow for simple switching off of the microphone.

In order to take advantage of the excellent automatic gain control provided by the SL6270 (IC1), in this project it has to be used in its less well-known single-ended mode. To use it in this mode, the signal is AC coupled (via C1 and C2) to one input (pin 5) while the other input (pin 4) is AC coupled (via C8) to ground, to reduce noise pick-up. Pin 5 is also tied to ground via a 22kΩ resistor to provide the correct DC bias to ensure that the internal offsets are such that the chip doesn't oscillate when the Automatic Gain Control (AGC) kicks in.

The input impedance for single-ended mode is 150Ω, and this together with C1 or C2, forms a high-pass filter. As we are interested in the beat of the music and hence low frequencies, we need to use reasonably large values for C1 and C2 to help reduce the attenuation of these frequencies (100μF gives a 3db cut-off of about 10Hz). The AGC of the SL6270 will provide an almost constant output signal of 90mV for input signals from 4 to 90mV. If we accept an output signal down to 45mV, we can extend the input range down to around 150μV. These input levels give us the design criteria for the microphone and direct signal inputs.

As dynamic microphones have a sensitivity of around −80dB and an impedance of about 600Ω, we can calculate the signal level into the SL6270 if it were used in its normal mode with an input impedance of 300Ω as follows:

Voltage at mic for 0dBm sound

$$= \sqrt{(600 \times 10^{-8})} = 2{\cdot}4mV$$

Voltage at SL6270 input

$$= 2{\cdot}4 \times \frac{300}{600} = 1{\cdot}2mV$$

If we used the same microphone in single-ended mode, we would only have:

$$= 2{\cdot}4 \times \frac{150}{600} = 600\mu V$$

Also, we would not have a simple means of disabling the microphone without switching the signal. (Switching the low level microphone signal can cause a lot of noise problems and is best avoided). By using an electret microphone and switching its DC off, we can disable it without any problems, also we regain the signal levels lost due to single-ended use of the SL6270. The sensitivity of an electret microphone is around −60dB and its impedance is around 1kΩ. This gives a voltage output at the microphone for a 0dBm signal of:

$$= \sqrt{(1000 \times 10^{-6})} = 31{\cdot}6mV$$

Voltage at SL6270 input

$$= 31{\cdot}6 \times \frac{150}{1000} = 4{\cdot}74mV$$

Which is back to a good input level. The electret microphone contains an amplifier which requires a DC supply of between 1·5 and 9V. This is supplied via R4, which is connected to IC1's filtered (via R17 and C12) 5V supply via a normally closed contact on the 3·5mm stereo audio input socket, SKT1. This conveniently disables the microphone when the jack plug is inserted into the socket.

The direct audio signal fed into SKT1 is divided down by R1, R2, R3 and the input impedance of IC1, to give an input signal level to IC1 of 3·1mV/V per channel (6·2mV/V) with an input impedance of approximately 47kΩ. This gives an input sensitivity range of:

Minimum (for 45mV IC1 output)
SKT1 input = 24mV

Maximum (for 90mV IC1 input)
SKT1 input = 14V

As most line outputs are around 1V rms, this dynamic range should be adequate.

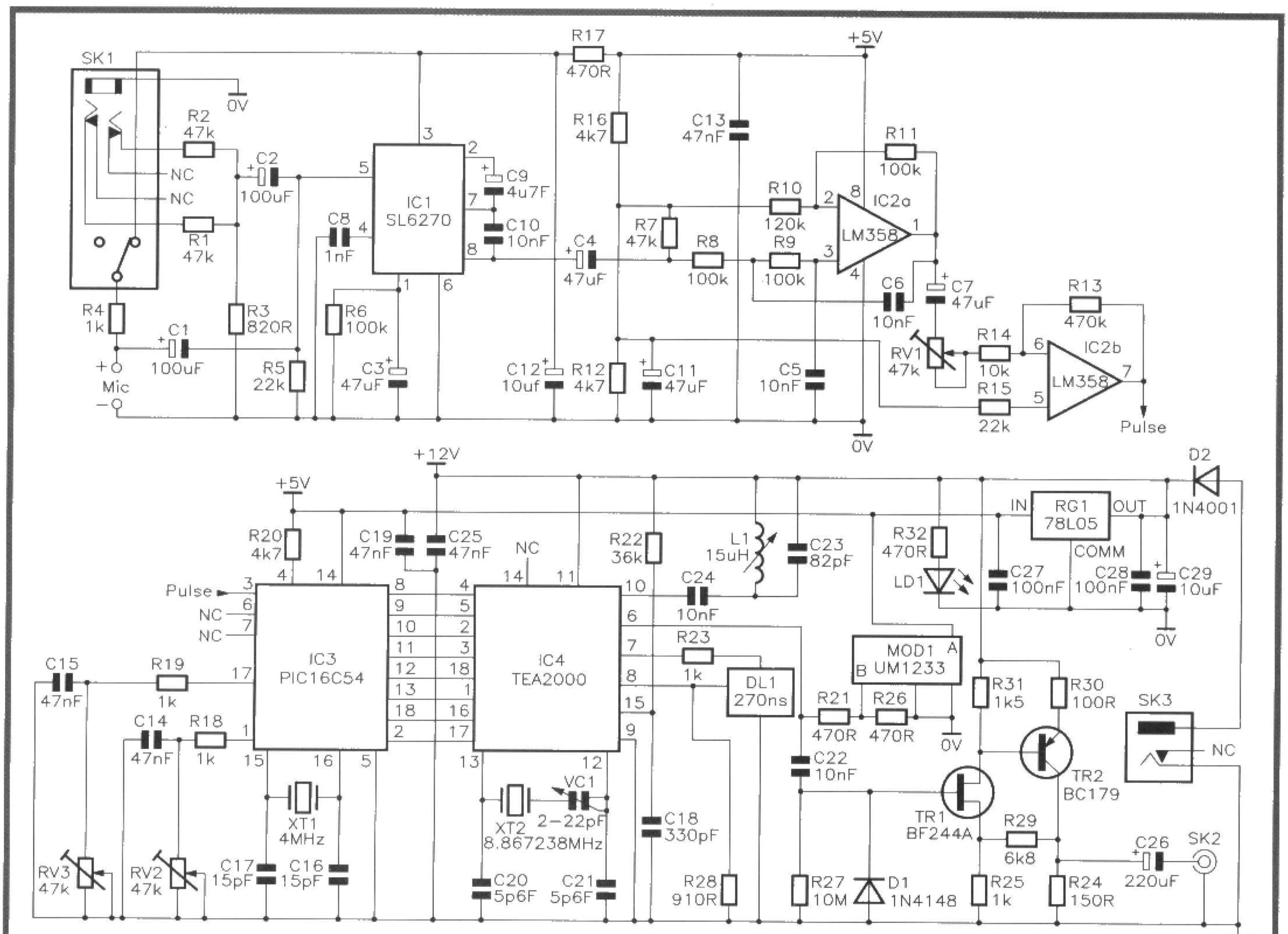


Figure 2. Video Kaleidoscope circuit diagram.

The attack and decay rates of the AGC circuit within the SL6270 are controlled by C3 and R6, respectively. As we are interested in the beat of the music, we want the AGC to respond to the mean level of the music but not to squash the beat. The attack time is calculated by the equation:

Attack Time = 0·4ms/μF (C3)

Therefore, 47μF gives us 18·8ms, which would just let through the first half cycle of a 50Hz drum beat, which is fine.

The decay time depends on R6 and C3, a value of 100kΩ gives 30dB/s, or in more understandable terms; after 1 second, it is 1,000 times more sensitive again. In fact, it doesn't quite happen like that, because as it is decaying, it will get to a point where the signal again fires the AGC to a greater or lesser amount, restarting the AGC cycle. In effect, the voltage on C3 settles down to a value proportional to the average signal level, occasionally peaking when there is an increase in signal level.

Since the SL6270 can have its frequency response tailored, we might as well use it to our advantage. The low frequency cutoff is calculated as:

$$f_L = \frac{1}{2 \times \pi \times 680 \times C9}$$

This must be greater than the AGC cycle time, or the IC will oscillate. A value for C9 of 4·7μF gives a cut-off of 50Hz, which is suitable. The high-frequency cut-off is calculated as:

$$f_H = \frac{1}{2 \times \pi \times 10{,}000 \times C10}$$

We could set this to be close to our 150Hz frequency that we are interested in, but there is a danger in doing this. Since the output of IC1 is the input to its AGC circuitry, the AGC will adjust itself to the content of the output. If that output only contains frequencies that we are interested in, the effect will be to squash all those frequencies, hence losing any beat information. By allowing other frequencies through, the AGC adjusts itself to the average music level, hence allowing beat information to pass through. A 10:1 range seems to be a sensible factor. A value for C10 of 10nF gives 1,590Hz. The output of this amplifier is then fed via C4 to the low-pass filter and threshold amplifier.

Low-pass Filter and Threshold Amplifier

This part of the circuit is based around the dual op amp, LM358. Even though it is a single-rail supply op amp, we still have to provide a mid-rail reference. This is done using R16, R12 and C11. The values are chosen to allow roughly ten times the current to flow through the potential divider than the amount of current drawn by components using the reference. This, together with C11 acting as a reservoir-cum-filter, gives a nice, stable mid-rail reference.

The low-pass filter is a 2-pole voltage-controlled voltage-source (VCVS) Chebyshev active filter, with 0·5dB of passband ripple. It consists of IC2a, R8-11, C5 and C6. As we are interested in the beat of the music, and most of the beat information is contained in the lower frequencies, 150Hz would be a good choice for the cut-off frequency of the filter. Also, we want a reasonably fast cut-off, to stop higher frequencies from triggering the Video Kaleidoscope.

Choosing a 0·5dB 2-pole Chebyshev and using the closest preferred component values, we end up with a cut-off frequency of 107Hz. Note that for a Chebyshev filter, the cut-off frequency is defined as the frequency where the amplitude response falls out of the ripple band. The −3dB frequency is 1·39 times this value, equal in this circuit to 149Hz.

As the input to the low-pass filter is AC coupled in this circuit, we need to provided a DC bias by connecting the input to the mid-rail reference, via R7. This ensures that the output of IC2a sits at around the mid-rail value (2·5V) when there is no signal present. The output of the low-pass filter is fed via C7 to the variable gain threshold amplifier. This consists of IC2b, RV1, R13-15. The gain of this amplifier is adjustable by RV1 from approximately 8 to 50. With no input signal, the output of the amplifier sits at around 2·5V, mid-way between the threshold levels of the Schmitt trigger RTCC input of the PIC16C54, to which it is connected. This Schmitt trigger input actually forms part of the threshold circuit, its threshold levels are:

Low: 0·75V
High: 4·25V

Thus, the input signal would require an amplitude of 4·25 −2·5 = 1·75V to trigger the RTCC circuit.

Since the nominal signal level into the low-pass filter and hence, the threshold amplifier, is 90mV rms, the rms input signal to the RTCC can be adjusted (in theory) between 0·72 and 4·5V. This equates to signal amplitudes of 1 and 6·3V, but as the LM358 can only drive to within about 0·1V of each rail, the maximum input amplitude to RTCC is 2·4V, i.e. 0·1 to 4·9V.

If there is a steady signal within the passband of the low-pass filter (say 100Hz), which is large enough to activate the AGC of IC1, then a 126mV amplitude (90mV rms) signal will be fed to the input of the threshold amplifier. With the gain of the amplifier set to about 15, there will be a 1·9V signal applied to the Schmitt trigger of the RTCC input. This will trigger the RTCC on each cycle of the signal, generating a 100Hz pulse train for the pattern generator to analyse.

As music consists of beats of low-frequency sound, this will generate a pulse train on each beat, allowing the pattern generator to distinguish between different tone beats. If the gain of the threshold amplifier is set to less than 13, the RTCC will not be triggered by the steady signal, but will be triggered by abrupt changes in the signal amplitude (see the AGC attack time discussion earlier). This will tend to give only one or two pulses per beat, and will cause different pattern progression and mutation effects from those achieved with a gain setting of around 15.

Higher gain settings are useful to compensate for quiet music or music which does not contain many low-frequency beats. In this way, the Video Kaleidoscope can be used for all types of music. The RTCC input forms part of the PIC16C54 microcontroller.

Microcontroller

The PIC16C54 microcontroller (IC3), together with its software, form the heart of the Video Kaleidoscope. Functionally, they can be split into 9 sub-blocks. Each of these will be discussed in turn below. The PIC16C54 itself is an 8-bit microcontroller, with 512 words of PROM and 32 register bytes. Each program word is 12 bits long. Of the 32 registers, 8 of them are dedicated to specific functions within the PIC16C54, such as input/output ports, control registers, etc.

There are two bidirectional input/output ports, one is 4 bits wide (Port A), the other 8 bits wide (Port B). Each I/O pin can source or sink 20mA maximum. In addition to the I/O ports, there is a single real-time clock/counter (RTCC) input, which can be used to trigger the RTCC counter register. This counter register forms the basis of the pulse analyser block.

As the PIC16C54 contains an internal power-up reset circuit, it is only necessary to tie the MCLR input to 5V via resistor R20. This power-up circuit disables the microprocessor within the chip from starting until the oscillator circuit has had time to establish steady running.

Crystal-controlled Clock Generator

This provides the 1MHz internal clock for all timing functions within IC3, its timing components are XT1, C16 and C17. The capacitors help to ensure that the oscillator starts up reliably. Notice that the crystal frequency is 4MHz, as there is a divide-by-4 circuit within the clock generator.

PAL Colour Modulator

The PAL colour modulator is based around the TEA2000 colour encoder and video summer chip (IC4). This chip contains a crystal controlled oscillator, the timing components of which are XT2, C20, C21 and VC1. The fixed value capacitors are to help ensure that the oscillator starts reliably. The trimmer capacitor is required so that the oscillator can be tuned exactly to the correct frequency, to generate the PAL colour clock.

A quadrature generator then produces the correctly phased signals for the R-Y and B-Y modulators. The phase of the R-Y signal is reversed every two lines by a phase inverter. The modulators are also fed from the R-Y and B-Y encoders, which convert the 6-bit binary colour input to the R-Y and B-Y analogue signals. The output from the modulators is combined with the colour burst signal, and is filtered by a 4·43MHz filter, consisting of components C23, C24 and L1.

The timing of the colour burst is controlled by the colour burst ramp generator, with timing components R22 and C18. This generates a ramp waveform at each sync pulse, and as this ramp passes a certain threshold voltage,

it triggers the generation of the colour burst signal. The filtered output of the modulators is mixed with the delayed luminance signal generated by the luminance encoder. The delay (270ns) is provided by the delay line, DL1, R23 and R28. The luminance encoder converts the 6-bit colour signal to the corresponding grey level analogue signal. This is combined with the sync and blanking pulses to generate the composite luminance signal. Finally, the signal is buffered, and outputs from IC4 on pin 6 as a PAL composite video signal.

NTSC Operation

Should it be necessary to operate the Video Kaleidoscope with a television, or video equipment, using the NTSC standard, this can be achieved by linking pin 14 of IC4 to ground and changing various components, as indicated in Table 2.

Component	PAL	NTSC
XT2 Crystal	8·867238MHz	7·159100MHz
DL1 Delay Line	DL270 (270ns)	DL330 (330ns)
L1 Adjustable Coil	15µH	18µH
C23 Ceramic Disc	82pF	100pF
R21 1% Metal Film	470Ω	750Ω
R26 1% Metal Film	470Ω	510Ω
MOD1 UHF Modulator	UM1233	UM1622
PAL/NTSC Select	High (open circuit)	Low (pin 14 of IC4 to 0V)

Table 2. PAL/NTSC parts changes.

UHF and Video Output

The final stage of the Video Kaleidoscope generates the UHF signal and buffers the video signal. The UHF signal is generated by the UHF Modulator, MOD1, which is a type UM1233. The output of IC4 is attenuated by resistors R21 and R26 to scale it correctly for input to the modulator. The UHF signal produced is at around channel 36.

TR1, TR2 and associated components form a high input impedance buffer. This buffer has an output impedance of around 100Ω, and when connected to a 75Ω load provides a video signal of 1V Pk-to-Pk.

Video Sync Generator

Using the 1MHz clock and various software delays, this block produces the composite video sync signal. It also generates the blanking signals, to ensure that the kaleidoscope generated by the pattern generator and associated blocks is fairly central on the screen. The Video Kaleidoscope generates a fully interlaced picture.

Pulse Analyser

The block uses the data from RTCC counter register and/or an internally generated manual pulse rate to generate information for the pattern progression and mutation control blocks, about the beat repetition rate, beat tone and duration of breaks in the music. This information is updated once every 4 video frames (every 80ms, or 12·5 times a second). This limits the maximum rate of change of the patterns.

Manual Pulse Rate Generator/Auto Pulse Selection

This block generates the manual pulse rate. The pulse rate is selected using the SPEED control (RV3), which forms part of a single-slope analogue to digital converter together with C15, R19 and port A bit 0 of IC3. This works as follows: at the end of each video frame, bit 0 of port A is made into an output by setting the relevant bit in its TRIS register to logic 0. A logic 1 is then written to bit 0, forcing the output high. This charges C15 via R19 to around 4·3V. At the start of the next frame, bit 0 is made into an input by setting the relevant bit in its TRIS register to logic 1. At the end of each scan line, bit 0 is tested to see when it has become a logic 0, indicating that C15 has discharged via RV3 to below the low level of the input port (about 1V). The time constant of C15 and RV3 has been chosen so that it will take a maximum of around 32 scan lines (approximately 2ms) to discharge to this level. The scan line number when bit 0 goes to logic 0 is then the digital value of the SPEED control setting. This value is averaged over 4 video frames, to generate the final SPEED setting.

This gives 32 rate settings. Rate 0 is the Automatic Pulse selection, Rate 1 is one pattern change every 100 frames (1 every 2 seconds), Rate 31 is one pattern change every 7 frames (7 every second), and the rates in between are in 3 frame intervals, as outlined below:

Variable manual rate: maximum 7 screens per second
minimum 1 screen per 2 seconds
Auto rate: maximum 12·5 screens per second
minimum 0 (beat dependent)

When music is played into the system while in manual rate mode, the manual rate will approximately phase/frequency lock to the beat of the music. Also, for some types of pattern, the manual rate will cause the pattern to contract, while the music beat will cause the pattern to expand, which can create some interesting pulsating patterns.

Mode Selection and Control

This block controls which mode the pattern progression and mutation control is in. The mode is selected using the MODE control (RV2), which forms part of a single-slope analogue-to-digital (A/D) converter, together with C14, R18 and port A bit 2 of IC3. This gives 32 possible mode settings. Modes 0 to 15 are individual modes, and modes 16 to 31 are multiplexed modes. A visual indication of the selected mode is displayed on screen (see the Operating Guide). This block generates the multiplexed modes by cycling through modes 0 to 15 each video frame.

Pattern Progression and Mutation Control

The mode data and beat, tone and break data from the pulse analyser are used by this block to control the pattern generator. There are three main variables used to effect the type of patterns generated, these being:

i. The initial pattern colour (FCOL)
ii. The colour differential per pixel (CDP)
iii. The colour differential per line (CDDL)

By setting these variables to various values and adjusting their values dependent on beat, tone and break data, the various patterns and pattern progressions and mutations are generated.

Pattern Generator

Using the FCOL, CDP and CDDL variables, this block generates the pixels in sector 1 of the pattern, ready for the symmetry/kaleidoscopic generation block to copy to the remaining sectors. The formula

0	1	2	3	4	5	6
	3	5	7	9	11	13
		8	11	14	17	20
			15	19	23	27
				24	29	34
					35	41
						48

FCOL=0
CDB=1
CDDL=1

Figure 3. Sector 1 pixel values.

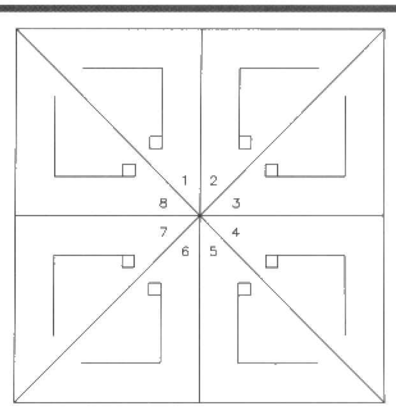


Figure 4. Relationship between sectors.

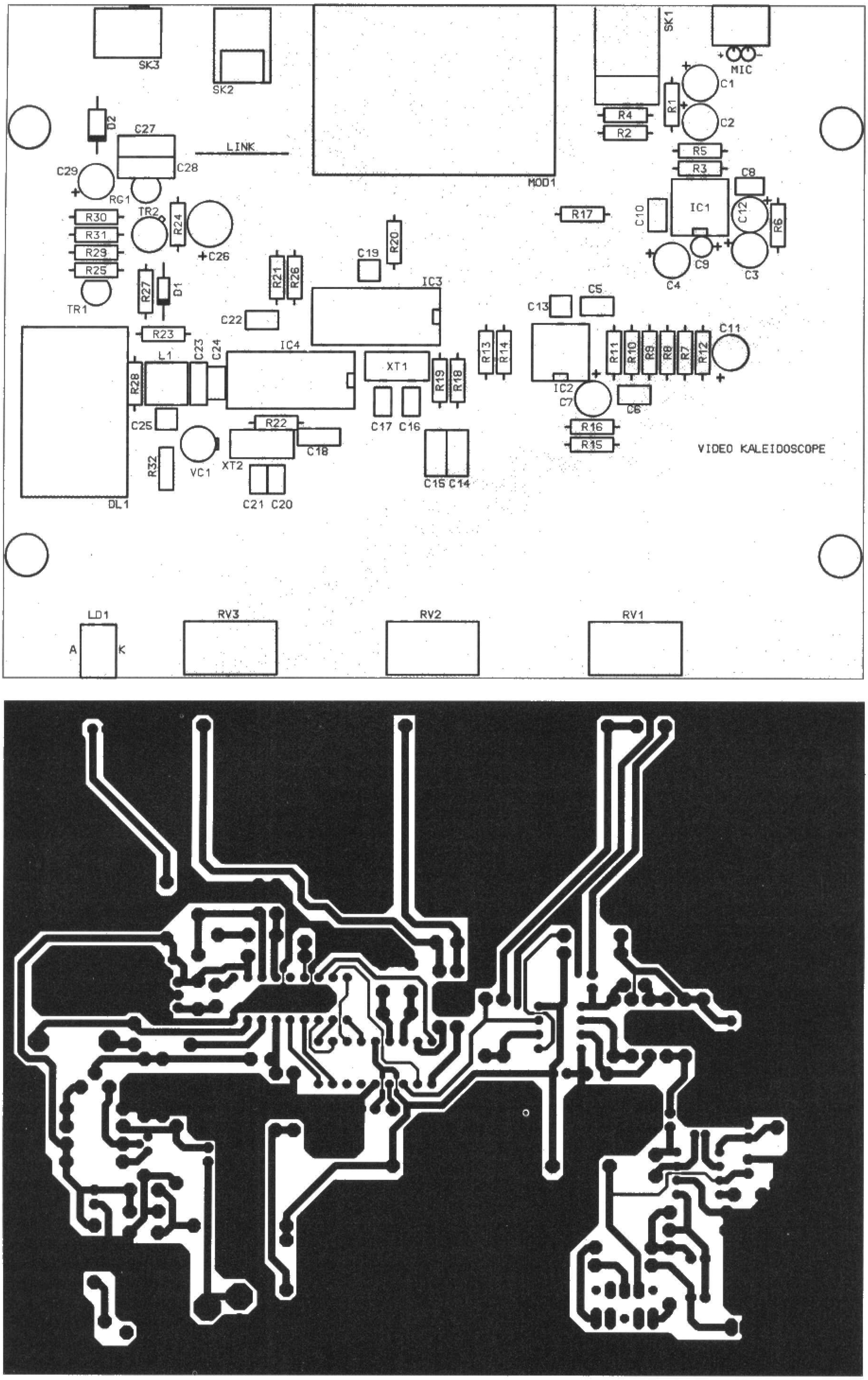


Figure 5. PCB legend and track.

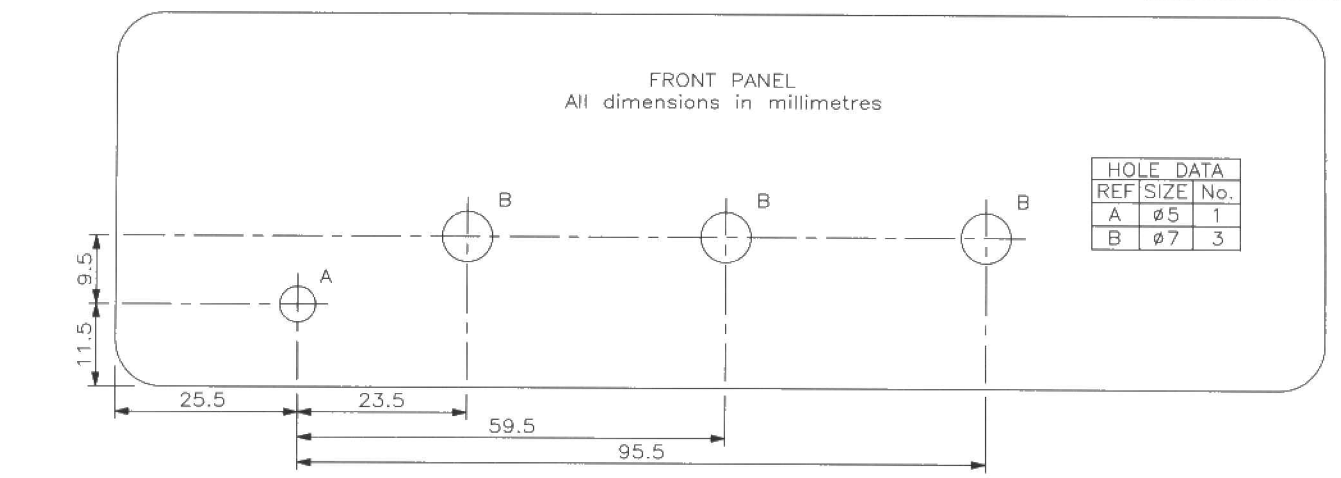


Figure 6. Front panel drilling diagram.

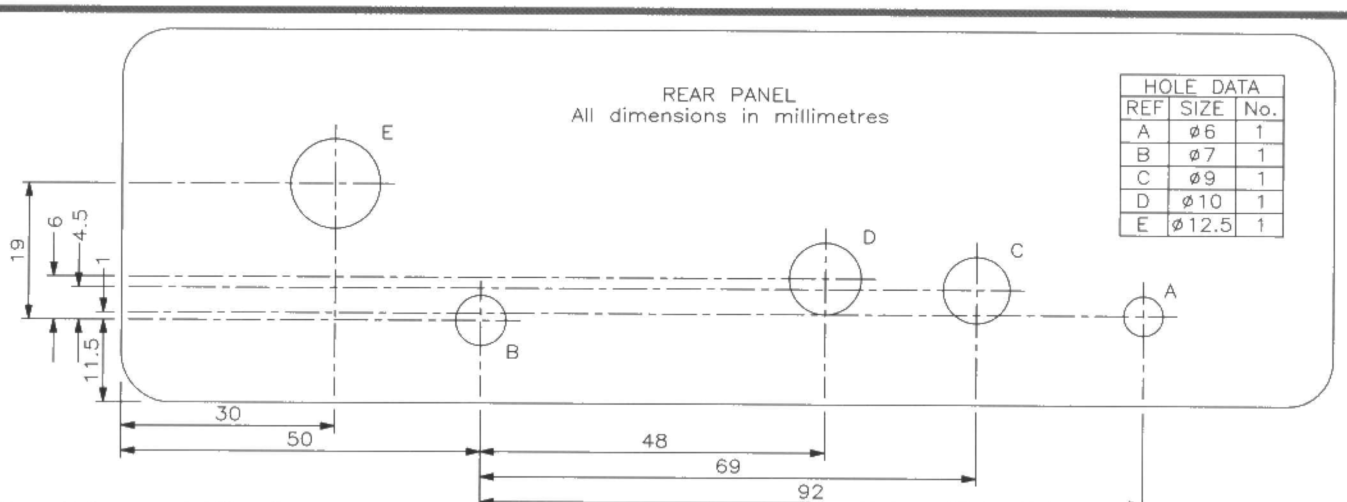


Figure 7. Rear panel drilling diagram.

used to calculate the value of each pixel of the sector is:

$Pij = FCOL + jCDP + iCDPj$

for: $j = 1-23$
$i = j-23$

Where:

$CDPj = CDP + jCCDL$

Figure 3 shows the pixel values generated for values of, FCOL = 0, CDB = 1, CDDL = 1, for a small part of sector 1.

Symmetry and Kaleidoscope Generation

This block copies sector 1 to the remaining 7 sectors, mirroring and rotating the sectors as necessary to produce the kaleidoscopic 4 axes of symmetry image. Figure 4 shows the relationship between each sector.

6-bit Colour Output

The pixel values generated by the previous blocks are mapped, 2 bits for each of red, green and blue, to produce a 6-bit colour value, which is sent via port B bits 2 to 7 to the PAL colour modulator.

The Power Supply

As mentioned above, the project requires a regulated 12V DC supply, such as that provided by the battery eliminator PSUs, Stock Codes CC10L, BZ83E, YZ21X or YB23A, via a 2·5mm power socket, with the centre pin positive. As life is often cruel and we all make mistakes, the circuit is protected from reverse power connection by diode D2, the cathode of which is connected to the reservoir capacitor C29.

Note: the circuit is not protected against over-voltage, so make sure that you use a regulated supply. If you do accidentally expose the circuit to more than 13·2V, you will probably destroy the PAL colour modulator (TEA2000), as it is the only IC connected to the 12V rail. (You would have to exceed 25V to damage the regulator or the transistors).

At the other extreme, the prototype worked down to a supply voltage of 7·5V. As this is below the lower limit of the TEA2000, it is not guaranteed. When supplied by 12V DC, the voltage on the 12V rail is actually 11·4V, due to the voltage drop through D2. This is acceptable, since the lower supply limit on the TEA2000 is 10·8V.

The nominal 12V rail is connected to the 78L05 regulator, RG1, which is decoupled both on its input and output by C27 and C28. These capacitors decouple the voltage sensing circuitry within the 78L05 from high-frequency signals, noise and power pulses, and help prevent the regulator from busting into oscillation. C27 also acts as a reservoir capacitor for any short power spikes. The 5V supply current is around 20mA, well within the capabilities of the 78L05. This means that it should run cool if all is well, as it will only be dissipating (12V – 5V) × 20mA = 170mW. The total current drawn from the 12V supply is around 80mA, 50mA of which goes to supply the TEA2000, quite a greedy chip.

PCB Assembly

Refer to the PCB legend and track diagram shown in Figure 5. Start by fitting the single link wire, then progress in order of ascending component size, ensuring correct orientation of the polarized components such as diodes, LED, electrolytic capacitors, semiconductors, electret microphone, delay line and the UHF modulator. Fit the IC sockets so that the notches align with those printed on the PCB legend. Make sure that all parts are fitted as closely to the board as possible, so as to minimise problems of stray signal susceptibility, which could otherwise result in video images rather more psychedelic than you bargained for!

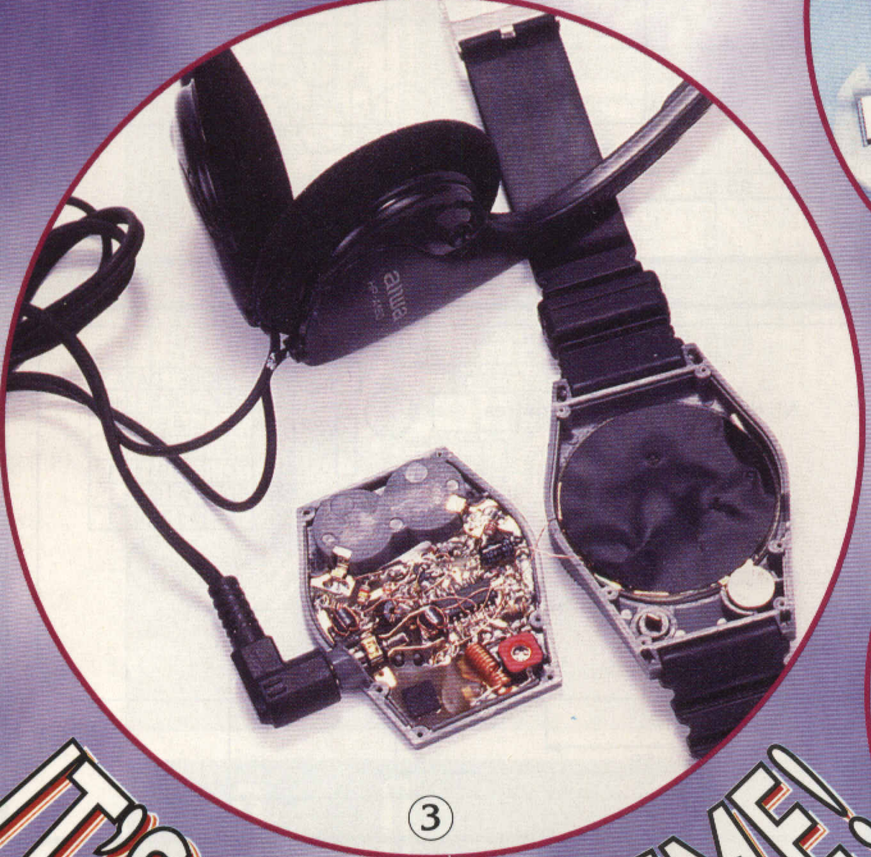
The three potentiometers RV1-3 should be prepared in accordance with Figure 9 before soldering them to the board. This involves cutting their spindles to a length of 14mm, and removing the tag off the body of each potentiometer. The electret microphone should be fitted as shown also in Figure 9, at a height of 22mm from the top face of the PCB.

Take care when soldering in the transistors, diodes, electret microphone

Continued on page 29.

This article aims to explore the inner workings, features and developments of that ubiquitous, essential piece of precision electronic equipment, that is largely taken for granted, namely, the modern-day timepiece – where would we all be without it?

1



3

2

IT'S ABOUT TIME!

by Maurice Hunt

A Chronology of the Modern Timepiece

Photo 4. FM radio watch (mono), with calculator and alarm. The radio circuitry runs from separate batteries to the watch section, and is switched on and off by insertion/removal of the earphones, the leads of which act as an aerial.

PARTICULARLY in wrist-watch form, some quite remarkable engineering is needed, to produce a unit that must be capable of maintaining an excellent standard of accuracy under what are quite harsh operating conditions – by wearing a watch every day, you subject it to occasional extremes of vibration and a wide temperature range (which can easily vary by about 20° the moment you venture outdoors), and yet, a typical accuracy of ±0·5 second a day (at worst) is expected, whereas prior to the age of quartz-controlled timepieces, an accuracy of ±5 seconds a day was considered very good-going for a clockwork mechanism; cheaper watches could lose or gain as much as a minute or so in 24 hours, and you had to remember to wind them up daily!

In addition to these demands, people (in the main) want watches and clocks that are inexpensive to purchase, yet will last for several years of being able to withstand the rigours of daily use, whilst retaining an unblemished casing appearance, and along with extra functions, such as alarm, day/date, various up/down timers, etc., a long battery life is required, of at least a year from a miniature sil-

ver-oxide, or lithium-type cell. Wrist-watches will usually also be required to be water-resistant to at least the minimum of splashing during hand-washing, or getting caught out in rainfall, etc., and possibly also to a specified depth of water to allow it to be worn during swimming or diving. To achieve these qualities, much careful design goes into the production of timepieces – the standard of the assembly process determines the ultimate accuracy and external appearance of the finished items, particularly those containing precision-machined, clockwork parts.

Early Electronic Timepieces

The first breakaway from the traditional, wind-up clockwork, analogue timepiece, occurred in the 1960s, when developments in transistor technology allowed a time regulation circuit to be miniaturised enough to be installed into small (analogue) clocks and watches, energising a coil, which in turn attracted/repelled small magnets attached to a rotating 'flywheel' which drove the remaining (conventional) movement of cogs and springs. Many clocks were built along similar lines, for mantelpieces and walls around the world.

Quartz Crystals

The demand for high and consistent standards of accuracy in electronic timepieces led to the development of quartz-crystal controlled oscillators as the basis for maintaining the overall timing of the circuitry used in watches and clocks, both analogue and digital, and they remain in use today, as they provide such a good level of accuracy over a fairly wide temperature range, and yet, are inexpensive, not overly upset by moderate vibration.

The quartz crystal used in timepieces, is almost universally, one which oscillates at a frequency of 32·768kHz, since this seemingly obscure figure is easily divided by half, fifteen times over (by means of a 2^{15} divider chain), to produce an accurate 1Hz (one beat per second) output, which the remaining timepiece circuitry can make use of to regulate the time and alarm functions. By extracting the signal from further up the divider chain, the 32Hz frequency used for the LCD backplane (which must be AC) is available, as are higher multiples of say, 4·096kHz for the alarm sound. Figure 1 shows the block diagram for a typical basic time, date and alarm function digital timepiece.

At one time, most electronic watches had the word 'Quartz' emblazoned somewhere across the face, and there were plenty of folk who thought that Quartz was a manufacturer; witness this in some of the classified adverts that appear in local newspapers, etc., that state something along the lines of 'Watch for sale . . . made by Quartz'!

Arrival of the Digital Age

Digital watches first hit the market in the early 1970s, with the introduction by manufacturers such as Texas Instruments and Timex, of the infa-

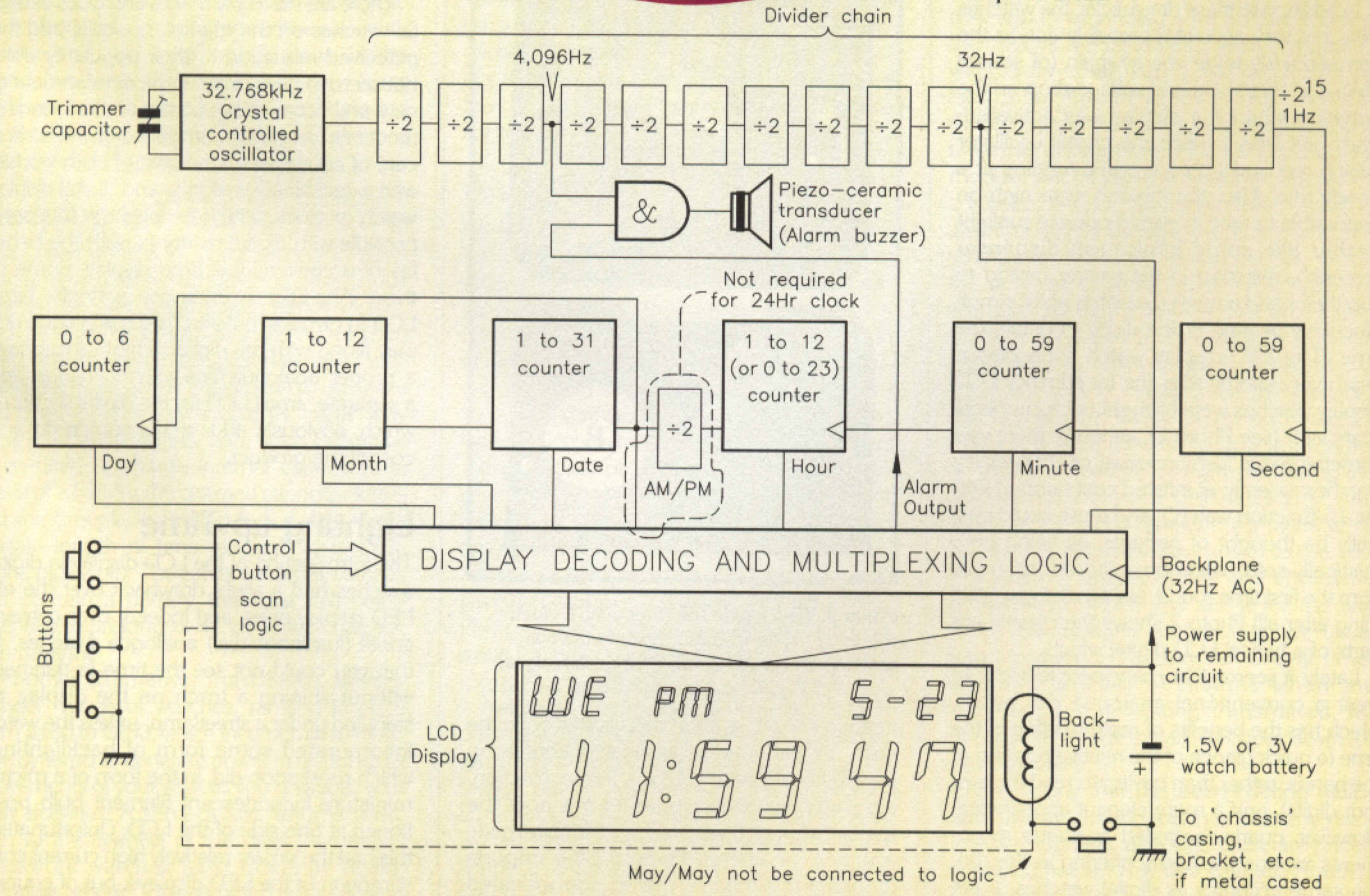
Photo 1. Early LCD display watch, from Texas Instruments – this version features a luminous display background, instead of the more usual backlight.

Photo 2. Constituent parts of a typical LCD digital watch. The module itself does not much to it, in comparison to clockwork watch innards. The module usually contains a PCB (often gold-plated) with single flat-pack IC bonded to it, backlight, quartz crystal and alarm coil (if required). There is also the LCD with conductive rubber connector strip, plus 'hardware' such as button and battery connectors.

Photo 3. Inside view of the FM radio watch – the radio circuitry is contained in the back half of the watch, the remainder is housed in the front section.

Photo 5. Citizen quartz analogue watch, with 1/50 second chronograph, alarm and tachymeter. It contains four micro-miniature stepper motors to drive the four sets of hands.

Figure 1. Block diagram of a basic digital timepiece circuit.



mous LED display watches, which soon became notorious for their battery-guzzling properties (at least two at a time, every 3 months or so), which meant that you had to press a button before the time would appear, and read it before the display switched off after a couple of seconds – the high current consumption of the (usually 4-digit) LED display meant that the time could not be permanently displayed, despite time-division multiplexing (TDM) being employed, whereby each digit is switched on for a fraction of a second in turn to offer reduced power dissipation. Day and date were obtained by pressing the button twice in rapid succession, whilst a flashing seconds display was given by holding the button in for a few seconds or more – hence, these watches were usually 5-function (hour, minute, seconds, day, and date), 6-function if you count the month accessible in 'set' mode.

Photo 6. View of the inside of the Citizen watch, with conventional quartz analogue watch beside for comparison. Note piezo-electric transducer disc attached to the watch back – this is the alarm sounder.

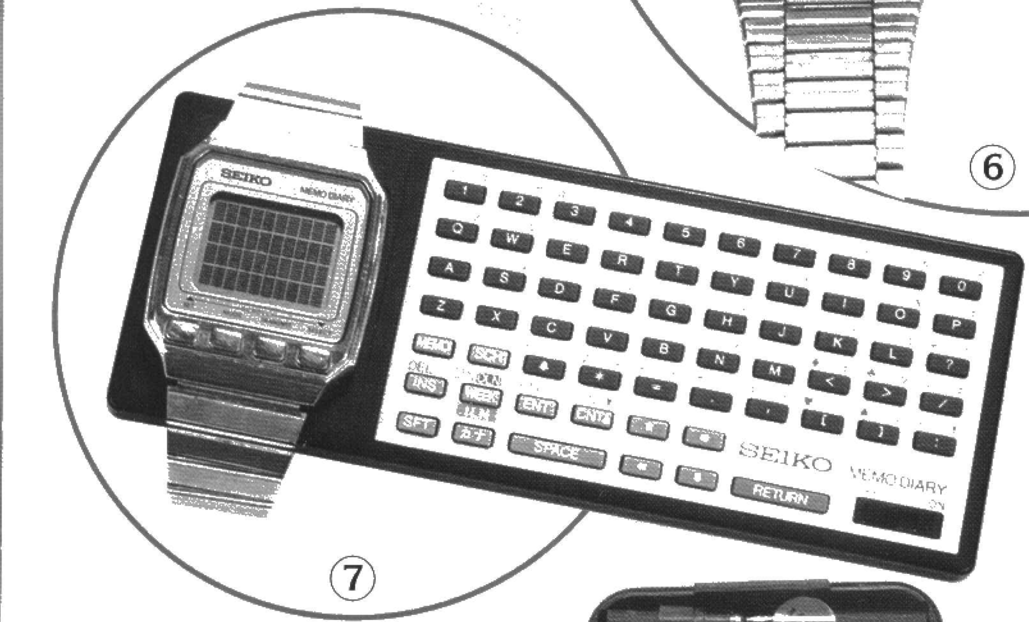


Photo 7. Seiko Memo Diary watch, with separate keyboard for data entry. This watch has a 4-row, 10-column dot-matrix LCD, and can store up to 100 lines of 10 characters each – these can be in English or Japanese alphabet (!) – in addition to schedule alarms and messages. Data is transmitted via sender and receiver coils in the keyboard and watch, respectively, which can be up to a few centimetres apart and still enable successful transmission.

In addition to these drawbacks, the watches were not very accurate, probably due to the comparatively huge energy drain (of several mA), and corresponding voltage drop on the batteries when the display was activated, which left little to keep the crystal oscillator (which required only a few μA) running at a steady rate. Also, the displays were nigh-on impossible to read in even moderate sunlight (rather like some bank cash dispenser screens!), resulting in the wearer having to cup their hand around the watch whilst simultaneously peering at the digits to obtain the time. The LED-display watch soon died a death very shortly after the far superior LCD display watches were brought out a couple of years later (see Photo 1), although there was something of a 'fashion revival' of LED-display watches recently, at inflated cost (around £40 for a 5-function watch!), and these could cynically be thought of perhaps, as being optimistically-sold, warehouse-stored left-overs from the first time round, fashion being a fickle thing after all! Photo 2 shows the constituent parts of a typical LCD digital watch.

Lately, it seems that many people prefer to wear a conventional analogue dial watch, which has the benefits of rapid reading of the time (a quick glance of the relative position of the hands, rather than having to read three or four digits), and a more elegant appearance. However, quartz-controlled analogue movements are now the norm, offering as they do, the same accuracy as digital watches, if not quite the same number of functions, and no need to wind it up each day, as was once the case. 'Proper' (and sophisticated, containing jewelled bearings, Incabloc shock protection, etc.) clockwork movements are now the reserve of very expensive, traditionally-made watches, or cheap, Eastern-Bloc imports (containing probably not-so sophisticated movements!).

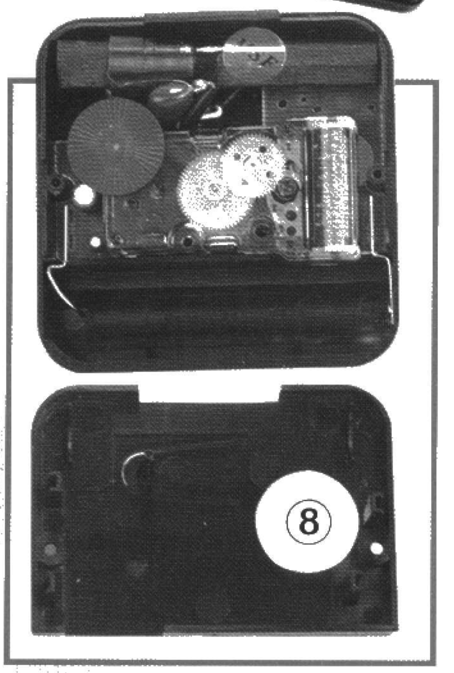


Photo 8. View inside the Rugby MSF clock module (Maplin RJ89W). Note ferrite/coil antenna for receiving the 60kHz MSF signal.

There are still many makes and types of digital watches on the market, however, and the perceived reduction in their popularity does not seem to have affected the development of new, and occasionally, bizarre and astounding functions on newly-introduced models. You can, of course, have the best of both worlds, with a combined analogue and digital display watch or clock, which enables the functions possible with digital readouts, with the benefits of a conventional time display. Some of these 'Ana-Digi' hybrids use a single, large LCD to give a simulated hands analogue display along with the digital, whilst others have a 'proper' analogue face with real hands, and a separate, small LCD for the digital section – which, obviously, adds to the complexity and cost of the product.

Lighting-up Time

The introduction of the LCD display in digital watches had a slight drawback over the old LED display ones, and indeed, over conventional (luminous-dial) analogue watches, in that you could not see the time in darkness without shining a torch on the display, or standing under a streetlamp, unless the watch incorporated some form of backlighting, which most soon did, in the form of a micro-miniature incandescent filament bulb positioned at one side of the LCD. Unfortunately, this had the similar relatively high current consumption of the LED displays, but of course, was not switched on as often, or for as long,

so battery life did not suffer too much if the backlight was used with discretion. However, some of these backlights were practically useless if badly positioned by the manufacturer, whereupon you would have to squint along the length of the screen to make out the numbers in darkness – difficult (and frustrating) whilst driving, for example.

A recent development, derived from aircraft instrumentation technology, is Electroluminescent (EL) backlighting of the LCD as a whole, with a uniform spread of light across its area – an example of this is Timex's 'Indiglo' (Corporation) series of watches (both analogue and digital), introduced in 1992, and numerous other manufacturers are now emulating this very worthwhile feature, with an already large range of watches and clocks now available incorporating EL backlighting. It utilises a special material that glows at room temperature when energised by a low power, high voltage, derived from inverter circuitry (similar to fluorescent lighting technology); with some of these EL-equipped units, you can hear a faint high-pitched noise being emitted when the backlighting is activated! The EL technology is also finding many other applications, including safety garments for wearing at night, styling stripes for car bodywork, car dashboard instrumentation, and even a saddle bag for bicycles – let's hope they don't all make a high-pitched noise!

It seems strange that more manufacturers have not utilised a luminous coating (as used on many conventional, analogue timepieces) for the LCD background panel (which is usually a reflective/silvered panel, detachable from the LCD if the module is taken apart), which would not place any extra load on the battery, but this is possibly due to some luminous paints being radioactive; with a large area of the coating this would be quite concentrated, and, perhaps, hazardous to health. One other problem with this, is that the luminosity fades after a few years (due to the relatively short half-life of the radioactive element), until eventually, it no longer glows in the dark! However, at least one make (Texas Instruments) did use a luminous background on some of their early (c.1976) LCD watches – an example is shown in Photo 1.

Keeping it Ticking

The power source for most electronic timepieces is a battery, a miniature silver-oxide type is used for watches/very small clocks, and penlight or C-size batteries for regular-sized clocks. Some manufacturers have made brave attempts (some successful) to eliminate the need for a battery altogether, particularly in wristwatches. To this end, solar cells have been used to charge internal capacitors in place of a battery, the charged capacitor keeping the timepiece running in the dark, for a certain length of time (enough to last the night, plus a bit). The earlier solar-cell watches *did* contain a battery, the solar cell being intended to prolong its life, by trickle-charging it in daylight.

Another alternative, from Seiko, is their 'Kinetic' range of watches, ranging in price from £180 to £200, which incorporate a miniature dynamo to generate power in response to movements of your wrist as you go about your daily activities. A semi-circular rotor is used, akin to the flywheel of the older 'automatic' clockwork watches (also made by Seiko, amongst others). Instead of the rotor winding up a mainspring, however, the Kinetic system uses the energy of the rotor to drive, via small cogs, the generator which rotates at up to a claimed 100,000rpm! This generates around 2·5V in normal use, only small movements of the wrist are needed to get the rotor moving, and one day's wearing of the watch generates enough stored energy to keep the watch running for a further three days of non-use.

An Embarrassment of Features!

Despite the impracticalities of the early LED displays, digital watches retained their popularity, particularly the next generation of LCD display versions (which took over in the digital watch market, up to the present day), and makers such as Casio, Seiko, Timex and the myriad of less well-known, far-eastern makes, were soon bringing out new models practically each week, with a seemingly limitless progression in the number of functions offered, to the point where a ridiculous number of buttons were needed to access them all; this could total twenty or more, dotted around every spare millimetre of the casing, even extending onto the front face and wrist-straps of the watch – particularly applicable to calculator and memo watches.

In addition to the 'humdrum' time, date, stopwatch and alarm functions that everyone expects, the modern-day digital watch can now offer such delights as countdown timers and multi-mode chronographs (fancy name for a sophisticated stopwatch), musical/melody alarms, jogging rate/cadence bleeper, pedometer (measures how far you have walked/ran), 'reminder' messages, calculator, world time, full calender display, special graphic displays, altimeter (shows how high up from sea level your wrist is), heart-rate and blood pressure monitoring, temperature and barometric reading, relative humidity, memorandum/telephone numbers/address storage, speech relaying of the time, TV and video infra-red remote-control, 'shoot 'em up' games, FM radio (see Photos 3 and 4 showing such a watch), etc., and these are just a few of the functions that could possibly serve some valid purpose on rare occasions!

Analogue Advances

Analogue watches have not been totally left behind in the features stakes, however, with some modern quartz analogue models boasting such functions as alarm, stopwatch (accurate to 1/50 second), tachymeter (used in conjunction with the stopwatch, to give a readout of speed in mph or kph), countdown timer, plus day/date. This has been possible by using micro-miniature stepper motors (as many as four or five), controlled by microprocessors, and driving four or more sets of hands, one to show the normal and alarm times, and the others for the timer functions. Amazingly, the battery life of this type of watch is very acceptable – typically, at least a year. Photos 5 and 6 depict a Citizen version of a multi-function quartz analogue watch, with alarm, stopwatch and countdown facilities.

Naturally, the number of functions a watch offers are in direct proportion to its purchase price, and usually, inverse proportion to its battery life, but even for the meagre price of around £10, it is possible to buy a watch with the admittedly useful alarm and stopwatch features, and for twice that price, you get a watch with quite a high specification. There used to be a rash of petrol stations with cheap 'garage' watches on offer at about £1.99 or so, offering a basic 5-functions plus backlit LCD display, in resin or stainless-steel case/strap versions, but these have subdued lately except from street markets and car boot sales; perhaps no-one wants such an obviously 'budget' watch any more, but they did represent very good value for money (it would cost far more than £2 to buy just the strap and battery separately) and some were even quite accurate into the bargain!

Some watches now require additional plug-in/on extras to make use of all the functions they offer, for example, a separate keyboard unit for entering in memos, the data being transmitted by means of transmitter and receiver coils in the keyboard unit and watch, respectively – Photo 7 shows an example of this type of 'mini-computer' watch, made by Seiko. There is also a watch available with a remote extension button (on a cable) for activation of the stopwatch, similar to that of an SLR camera remote shutter device; this is intended to give more accurate/convenient control over the stopwatch, worthwhile when it is capable of measuring down to the nearest 1/100th or even, 1/1,000th of a second.

A recent addition to the watch market, is the Timex/Microsoft Data Link Watch, costing around £100, which allows you to send information such as lists, phone numbers, dates etc., from your PC to the watch, simply by pointing the watch face at the computer screen. In a matter of seconds, PIM data is transferred by light waves (by means of the software supplied) from the PC to the watch, which incidentally, also features Indiglo display backlighting.

Radio-Controlled Timekeeping

Despite a slow start in their sales, due to high initial cost, radio-controlled timepieces are now rapidly expanding onto the market, and their prices are becoming quite acceptable, with radio-controlled clock modules, for example, Maplin's MSF clock module (RJ89W) illustrated in Photo 8, costing about twice that of its equivalent conventional quartz module, but far more interesting! The radio-controlled timepieces contain radio receiving and time-signal decoding circuitry, and are tuned into dedicated frequencies on which the time signal services are broadcast, for example, the 60kHz MSF signal from Rugby, which is controlled by the National Physical Laboratory to ensure superb standards of accuracy, or the signal from the German Atomic Caesium Clock, based in Frankfurt.

When a time (and/or date, if applicable) correction is needed, for example, during the changeover between GMT and BST, the hands of the clock or watch (or digits of its display) are automatically moved to the correct setting – quite a bizarre and impressive phenomenon when you see it for the first time! The modules incorporate the usual quartz regulator circuitry for overall timekeeping, and for occasions when the time signal is not being transmitted, for example, when the transmitter goes down for maintenance.

A company that has been offering radio-controlled clocks and watches for many years now, is Junghans, although these are priced at the higher end of this market. Another maker, Eurochron, produces an LCD digital travel-alarm type version.

Collectors' Corner

With the vast variety of different makes and types of watches and clocks that have been sold over the years, it is not surprising that there are many collectors of all types of timepiece, and not just the antique ones!

It is highly likely that the earliest forms of electronic watches will become collectable, and eventually, valuable, that is, if they aren't already. Timepieces that represented a breakthrough in terms of technological advancement, or ones which are rare or were, conversely, for some reason, very popular, will naturally, be the most highly-prized. Indeed, some fairly recent versions of the very popular Swatch range of offbeat-patterned, resin-cased quartz analogue watches are already commanding prices of hundreds, or even thousands of pounds, amongst avid collectors, despite their low cost of around £25 each.

Ironically, this Swiss manufacturer produced these easy and cheap-to-make watches (the production line churns them out at a rate of one every 20 seconds or so!), to avert a crisis in the Swiss watch industry, when everyone started buying cheap far-Eastern timepieces instead of their arguably superior quality, but far more costly watches – it was a marketing plan that worked brilliantly. Of course, there will always be a market for the traditional, hugely expensive Swiss (and other countries') 'craftsmen'-built, clockwork clocks and watches, more for their status symbol presence than for their accuracy compared to Quartz ones – they need regular servicing of their movements to keep them anywhere near as accurate.

Future Developments

With the ever-ongoing miniaturisation in electronics, it will only be a matter of time before a self-contained TV watch emerges (there have already been examples of these, but they have not been totally self-contained, having separate power supplies, tuners, etc.). With voice-recording ICs already available, there will undoubtedly soon be watches capable of digitally recording your voice messages, for helping you remember sudden flashes of inspiration/ideas wherever you may be – pens are already available with such a feature, but quite expensive, at around £80.

Mobile telephones are constantly being made ever smaller, so to have one built into a wristwatch is a very likely possibility in the future, though it would not perhaps have quite the same 'pose factor', speaking into your watch, that mobiles currently entertain! This feature could perhaps, eventually be combined with the TV function, to provide a videophone system, á la *Star Trek*. Other possi- bilities might be an air-quality function, to help you decide whether or not to don your air filter mask before venturing outdoors, radiation alert/Geiger counter (In fact, 2,200 such watches are currently being constructed, for issue to the Indian army, in the event of nuclear warfare – an ominous sign?), additional, universal, coded remote controls on your watch, to activate the doors to your home/garage/gate, car alarm and stereo, multi-media home entertainment system, etc. And, how about a National Lottery numbers predictor function!

It is highly likely that more timepieces, perhaps eventually, the majority, will be produced featuring automatic adjusting and correction of the time, by means of reception of the Rugby MSF signal, or its equivalent in other countries.

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AUDIO

HAMMOND 126JM2 PARTS. Power amp board and transformer, EOP/MO board, divider board, plugs, service manual, etc. £45 carriage paid. Tel: Sean (0141) 959 7466

COMPUTERS

1Mb ATARI STFM COMPUTER, with internal and external disk drives (720K) with clock cartridge and software, £120. Also MAPSAT system, £60. Tel: Anthony (01733) 311858 (after 7pm weekday evenings).

COMPAQ CONTURA AERO 4Mb memory modules (manufacturer's No. 190532-001), brand new, unopened, £90. Tel: (01727) 760412.

MICROSOFT SPACE SIMM. Used once. Very good condition £20 including postage. For details write to: Oliver Lindley, 119 Oaklands Park, Buckfastleigh, Devon TQ11 0BW.

VARIOUS

A1 SECURITY AUTO-DIALLER 'The Communicator' (Maplin Stock Code GL03D) with two rechargeable Ni-Cad back-up batteries. Interfaces to any house security system with a 12V siren output and will relay up to four separate messages to up to four different telephone numbers when the alarm system has been triggered. As new and still in original packaging, £50. Tel: Tony Bricknell (01702) 554155 Ext. 244 (Day), (01702) 231427 (Evenings).

AVO 8 Mk. 5, complete with leather case. Splendid condition, recent manufacturer's calibration. Current distributor's price for outfit £480 plus VAT. Only £260 collected (Reading), or carriage at cost. Tel: (01734) 415061.

MANUALS, Ferrograph Series 4 and Series 7. £10 each. Also *Practical Wireless*, Valve Circuits by John Scott-Taggart, 1922, Offers. Tel: J. Rees (01670) 590406.

WANTED

HEATHKIT HW8, Quad stereo receiver and preamp, infomation on KB wire recorder/ gramaphone. Douglas G3KPO, Tel: (01983) 567665.

VINTAGE FUZZ BOX circuit diagrams for guitar. Tel: Paul (0181) 581 4683.

CIRCUIT DIAGRAM/SERVICE MANUALS for Advance Pulse Generator PG55. Ferrograph Magnetac (Tape) recorder YD 6 BL/CA/R or any Ferrograph data Ricoh Fax 20. Tel: (01869) 347504.

CORRESPONDENT, retired. Interested in constructing shortwave receivers. Contact: John Noble, 1 Mierscourt Farm Cottages, Mierscourt Road, Rainham, Kent ME8 8PJ.

BBS CORNER

APPLE CRACKERS. FirstClass Client BBS, mainly for AppleMac and PC users. Baud rate 2·4K-bit/s to 14·4K-bit/s, 8 data bits, no parity, 1 stop bit. Tel: (01268) 781318/780724.

MACTEL METRO/ICONEX. FirstClass Client BBS, AppleMac and PC users. E-mail address on Internet for registered users. Baud rate 2·4K-bit/s to 14·4K-bit/s, 8 data bits, no parity, 1 stop bit. Tel: (0181) 543 8017 (Metro) or (0115) 9455417 (Iconex).

SPIDER! AMIGA BBS. The lighter alternative. Mainly Amiga and some PC files. Fidonet, Mercurynet and Mufonet. Online games. Speeds up to 19200. Tel: (01568) 613520.

CLUB CORNER

AARS (Aberdeen Amateur Radio Society) meets on Friday evenings in the RC Hall, 70 Cairngorm Crescent, Kincorth. For details contact: Martin, (CM0JCN), Tel (01569) 731177.

CRYSTAL PALACE & DISTRICT RADIO CLUB. Meets on the third Saturday of each month at All Saints Church Parish Rooms, Beulah Hill, London SE19. Details from Wilf Taylor, (G3DSC), Tel: (0181) 699 5732 or Bob Burns, (G3OOU), Tel: (01737) 552170.

E.U.G. User group for all 8-bit Acorn Micros, since 1991. Still going strong. Programming, news, information, sales. Contact: E.U.G., 25 Bertie Road, Southsea, Hants. PO4 8JX. Tel: (01705) 781168.

MODEL RAILWAY ENTHUSIAST? How about joining 'MERG', the Model Electronic Railway Group. For more details contact: Paul King (Honorary Secretary), 25 Fir Tree Way, Hassocks, West Sussex BN6 8BU.

SCIENCE AT YOUR FINGERTIPS, for 'hands-on' science experiences and experiments, *Science at Your Fingertips Science Review*, Membership £2.50. For further details, please contact Daniel and Caroline Gee, The S.A.Y.F., 37 South Road, Watchet, Somerset TA23 0HG.

THE BRITISH AMATEUR ELECTRONICS CLUB (founded in 1966), for all interested in electronics. Four newsletters a year, help for members and more! UK subscription £8 a year (Junior members £4, overseas members £13.50). For further details send S.A.E. to: The Secretary, Mr. J. F. Davies, 70 Ash Road, Cuddington, Northwich, Cheshire CW8 2PB.

SEEMUG (South East Essex Mac User Group), meet in Southend, every second Monday of each month. For details Tel: Michael Foy (01702) 468062, or e-mail to mac@mikefoy.demon.co.uk.

SOUTHEND & DISTRICT RADIO SOCIETY meets at the Druid Venture Scout Centre, Southend, Essex every Thursday at 8pm. For further details, contact: P.O. Box 88, Rayleigh, Essex SS6 8NZ.

SUDBURY AND DISTRICT RADIO AMATEURS (SanDRA) meet in Gt. Cornard, Sudbury, Suffolk at 8.00pm. Visitors and new members are very welcome. Refreshments are available. For details please contact Tony, (G8LTY), Tel: (01787) 313212 before 10.00pm.

TESUG (The European Satellite User Group) for all satellite TV enthusiasts! Totally independent. TESUG provides the most up-to-date news available (through its monthly 'Footprint' newsletter, and a teletext service on the pan-European 'Super Channel'). It also provides a wide variety of help and information. Contact: Eric N. Wiltsher, TESUG, P.O. Box 576 Orpington, Kent BR6 9WY.

THANET ELECTRONICS CLUB. For school age Ham Radio and Electronics enthusiasts, enters its 16th Year. Meetings held every Monday evening from 7.30pm at The Quarterdeck, Zion Place, Margate, Kent. For further details contact: Dr. Ken L. Smith, (G3JIX), Tel: (01304) 812723

THE (WIGAN) DOUGLAS VALLEY AMATEUR RADIO SOCIETY meets on the first and third Thursdays of the month from 8.00pm at The Hesketh Arms, Shevington Moor, Shevington, Wigan. For further details contact: D. Snape, (G4GWG), (OTHR), Tel: (01942) 211397.

WINCHESTER AMATEUR RADIO CLUB meets on the third Friday of each month. For full programme contact: G4AXO, Tel: (01962) 860807.

WIRRAL AMATEUR RADIO SOCIETY meets at the Ivy Farm, Arrowe Park Road, Birkenhead every Tuesday evening, and formally on the the 1st and 3rd Wednesday of every month. Details: A. Seed, (G3FOO), 31 Withert Avenue, Bebington, Wirral L63 5NE

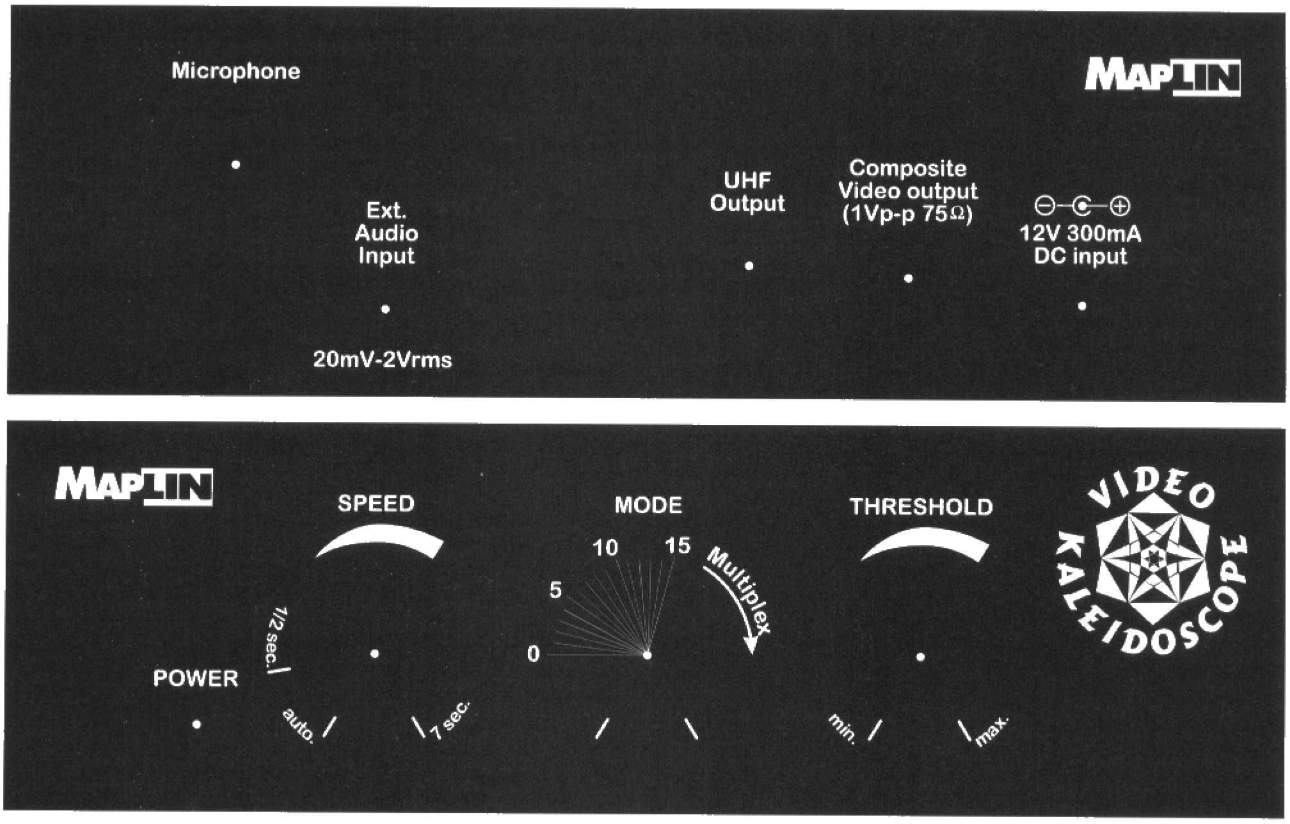


Figure 8. Video Kaleidoscope front and rear panel labels.

and quartz crystals, so as not to overheat them, or else hidden damage may result. Having completed the PCB assembly, check your work carefully for solder whiskers, bridges and dry joints, and remove excess flux using a suitable solvent.

The ICs should be inserted into their sockets last of all, taking antistatic precautions.

Case Assembly

Drill the side-fit front and rear panels of the recommended (optional) enclosure in accordance with the drilling diagrams given in Figures 6 and 7, using the front and rear panel labels shown in Figure 8 to assist you locate the holes, by using a pointed instrument poked through the hole positions marked on the labels as a guide, taking care not to damage the labels in the process. Affix the labels after having drilled, de-burred, and cleaned the panels.

Assemble the completed PCB to the front and rear box panels as depicted in Figure 9, securing the potentiometers to the front panel using the washers and nuts supplied with them. Next, install this sub-assembly into the lower half of the box by sliding the end panels along the guide slots, using spacers below the PCB, and the self-tapping screws supplied with the box to secure it in place.

Having satisfied yourself that your assembly work is correct, and after having tested and calibrated the unit as described below, the lid of the box can be fitted, using the four screws supplied with the box to secure it. Finally, fit the knobs onto the potentiometer spindles by means of the grub screws.

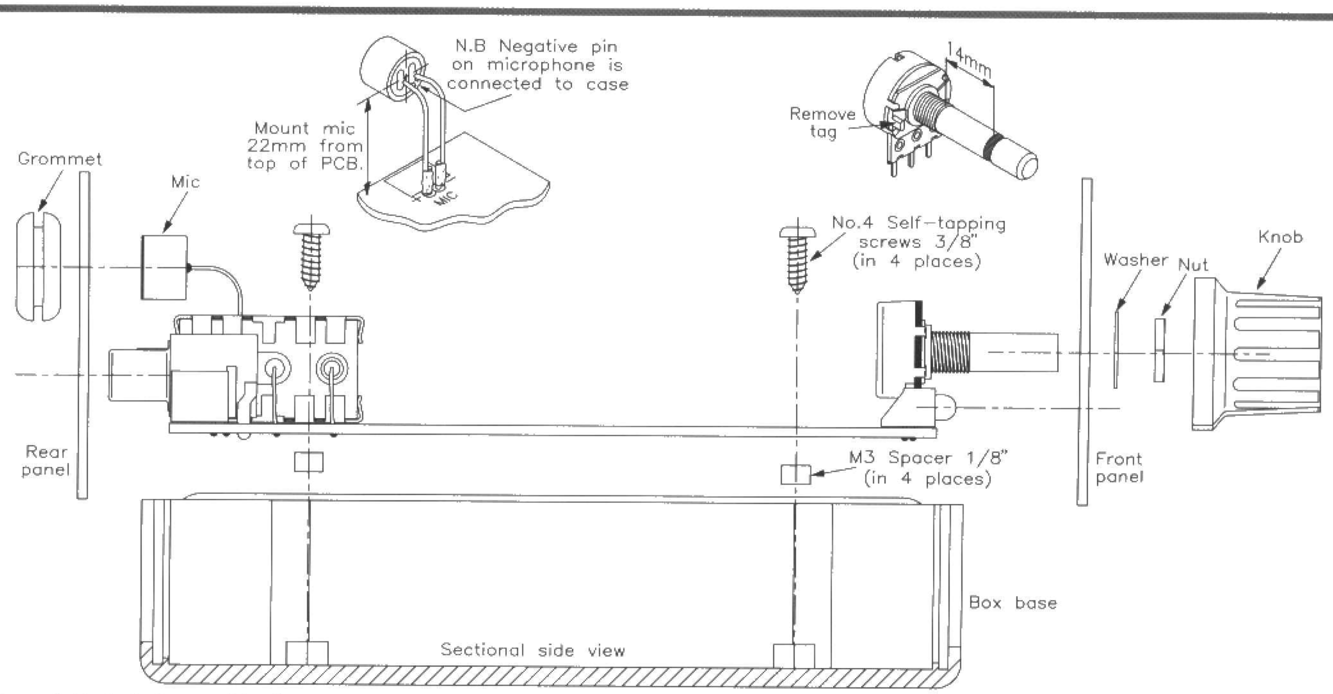


Figure 9. Exploded assembly diagram.

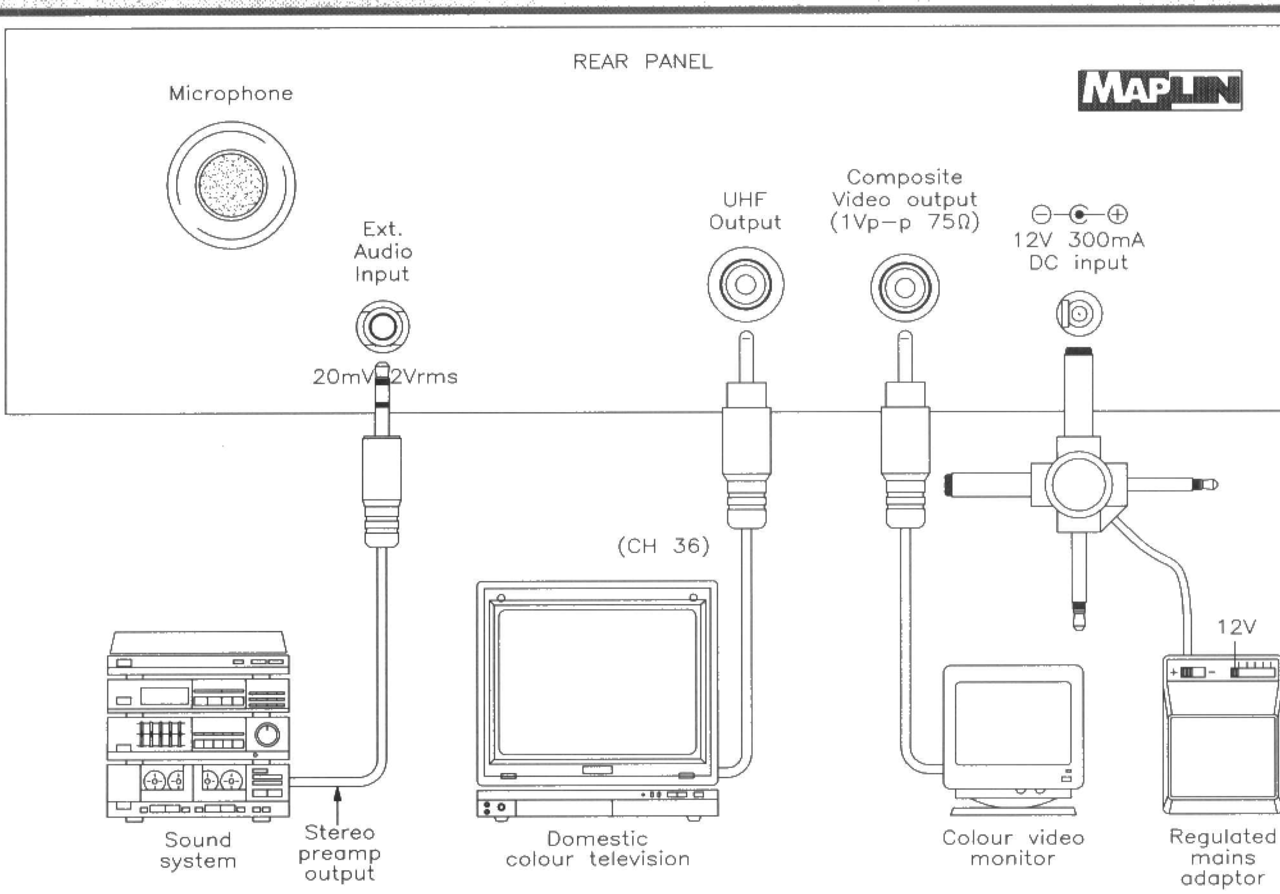


Figure 10. Typical installation wiring diagram.

Testing, Alignment and Operating Guide

The front and rear panel labels, shown in Figures 8 and 9, show the controls and connection sockets of the Video Kaleidoscope, and Figure 10 shows the typical installation wiring, which will be of assistance when setting up the unit. Connect the UHF output of the Video Kaleidoscope to the aerial socket of a colour TV using a suitable phono-to-coax cable. Tune the TV to around channel 36, and turn the volume right down or mute the TV audio. Connect the power supply to the Video Kaleidoscope and turn it on. You should see a kaleidoscopic pattern on the screen, if you do not, try tuning the TV either side of channel 36 until you get a steady pattern.

The trimmer capacitor VC1 and coil L1 will most likely require some tuning in to obtain the best picture results. Once a reasonable kaleidoscopic picture is displayed from adjustment of the TV, adjust VC1 until the colour locks in properly, concurrent with the crystal oscillating at 8·867238MHz. L1 is used to adjust the chrominance filter and hence, the video response, which is done following adjustment of VC1. Its setting has a slight but noticeable effect on the overall picture sharpness and quality, and should be adjusted until the picture is as good as possible, with sharp pattern edges and minimal 'interference' lines on the screen. All adjustments should be made with a core trimmer tool, such as BR51F.

To see the various patterns without playing any music, turn the SPEED control to about halfway and the MODE control fully anticlockwise. You should now see a MODE 0 pattern slowly progressing. Note on the far left of the screen, there is a small block about halfway down the screen – this is the mode indicator. Turn the MODE control slowly clockwise, and note how the mode indicator moves up the screen (there are two blocks, the lower block is simply a repeat of the first block and can be ignored). When you go past the 16th mode, notice how there are now several blocks flashing, these indicate which modes are being multiplexed in the multiplex modes.

Select a pleasing pattern mode, and now adjust the SPEED control to effect the rate at which the pattern progresses. The full range of patterns and pattern mutations cannot be achieved by use of the manual rate. This is because the Video Kaleidoscope analyses the structure of the beat of music to control the patterns, and as music is a complex signal, it can produce a wider range of patterns than the manual rate alone.

To use the Video Kaleidoscope with music, simply place it near your Hi-Fi speaker (within 5 feet), and turn the SPEED control fully anticlockwise. Now play your favourite music, and adjust the THRESHOLD control until the pattern starts to change in time to the music. Alternatively, you can connect the Video Kaleidoscope directly to your Hi-Fi auxiliary output or headphone connector, using the stereo audio input connector via a suitable cable.

Note that there are a wide range of settings of the THRESHOLD control which will produce pattern changes, and that the amount the pattern changes on each beat varies, depending on this setting. Also, different modes are affected differently by the THRESHOLD setting. The combination of these two controls can produce a wide range of pattern effects.

Most music contains breaks or quiet passages, and some of the Video Kaleidoscope modes detect these breaks and use them to time pattern mutations (i.e., major automatic pattern changes, as opposed to the smaller pattern changes on each beat). Mode 0 is one of the modes which detects breaks – urn the THRESHOLD control clockwise until the pattern is making simple changes on each beat, then when there is a break in the music, you will see the pattern change to a new one automatically on the next beat.

The manual rate control can also be used when playing music. To see the effect clearest, select the inward diamond mode (Mode 5), and set the THRESHOLD control so that diamond shrinks one or two steps with each beat of the music. Now turn the SPEED control clockwise until the diamond starts going the other way at about the same speed as the beat (when there is no beat). The diamond should now pulse in and out with the beat. Other modes 'phase lock' to the beat of the music when set to a manual rate. (Note that if the manual rate is set to above about 1 per second, then the break detection will not function, as there will effectively be no break in the signal to the pulse analyser within the Video Kaleidoscope.)

By experimenting with various settings of the three controls and using different types of music, a large range of patterns and pattern effects can be created. As a guide, use low threshold settings for quiet or atmospheric music, and high settings for dance and heavy metal. The mode settings are equally effective with all types of music.

VIDEO KALEIDOSCOPE PARTS LIST

Resistors: All 0·6W 1% Metal Film (Unless specified)

R1,2,7	47k	3	(M47K)
R3	820Ω	1	(M820R)
R4,18,19,23,25	1k	5	(M1K)
R5,15	22k	2	(M22K)
R6,8,9,11	100k	4	(M100K)
R10	120k	1	(M120K)
R12,16,20	4k7	3	(M4K7)
R13	470k	1	(M470K)
R14	10k	1	(M10K)
R17,21,26,32	470Ω	4	(M470R)
R22	36k	1	(M36K)
R24	150Ω	1	(M150R)
R27	10M	1	(M10M)
R28	910Ω	1	(M910R)
R29	6k8	1	(M6K8)
R30	100Ω	1	(M100R)
R31	1k5	1	(M1K5)
RV1,2,3	47k Miniature Linear Potentiometer	3	(JM73Q)

CAPACITORS

C1,2	100μF 10V Radial Electrolytic	2	(RK50E)
C3,4,7,11	47μF 16V Radial Electrolytic	4	(YY37S)
C5,6,10,22,24	10nF Mylar Film	5	(WW18U)
C8	1nF Ceramic Disc	1	(WX68Y)
C9	4μ7F 35V Radial Electrolytic	1	(AU05F)
C12,29	10μF 50V Radial Electrolytic	2	(YY35Q)
C13,19,25	47nF 50V Ceramic Disc	3	(BX02C)
C14,15	47nF Mylar Film	2	(WW20W)
C16,17	15pF Ceramic Disc	2	(WX46A)
C18	330pF Ceramic Disc	1	(WX62S)
C20,21	5p6F Ceramic Disc	2	(WX41U)
C23	82pF Ceramic Disc	1	(WX55K)
C26	220μF 16V Radial Electrolytic	1	(FF13P)
C27,28	100nF 50V Ceramic Disc	2	(BX03D)
VC1	22pF Trimmer	1	(WL70M)

SEMICONDUCTORS

D1	1N4148	1	(QL80B)
D2	1N4001	1	(QL73Q)
LD1	PCB Mounting LED (Red)	1	(QY86T)
TR1	BF244A	1	(QF16S)
TR2	BC179	1	(QB54J)
RG1	LM78L05ACZ	1	(QL26D)
IC1	SL6270CDP	1	(UM73Q)
IC2	LM358N	1	(UJ34M)
IC3	PIC16C54X MS08	1	(GV12N)
IC4	TEA2000-V1	1	(UH66W)
XT1	4MHz Crystal	1	(FY82D)
XT2	8·867238MHz Crystal	1	(UH85G)
L1	15μH Adjustable Coil	1	(UH86T)
DL1	DL270 Delay Line	1	(UH84F)
MOD1	UHF Modulator, Type UM1233	1	(FT30H)

MISCELLANEOUS

MIC1	Subminiature Omnidirectional Microphone Insert	1	(FS43W)
SK1	1-pole 2-way PCB Mounting 3·5mm Stereo Jack Socket	1	(JM22Y)
SK2	PCB Mounting Phono Socket	1	(HF99H)
SK3	PCB 2·5mm DC Power Socket	1	(FK06G)
	8-pin DIL Socket	2	(BL17T)
	18-pin DIL Socket	2	(HQ76H)
	PCB Pins 1mm	1 Pkt	(FL24B)
	Front Panel Label	1	(90081)
	PCB	1	(90074)
	Instruction Leaflet	1	(XV75S)
	Constructors' Guide	1	(XH79L)

OPTIONAL (Not in Kit)

	12V 1A Regulated Power Supply	1	(CC10L)
	Phono Plug to Coax Plug Video Lead	1	(FV90X)
	Plastic Instrument Case	1	(KC61R)
	Matt Black Knob, Type K14C	3	(FK40T)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items (excluding Optional) are available as a kit, which offers a saving over buying the parts separately.

Order As 90073 (Video Kaleidoscope) Price £39.99 A1

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue

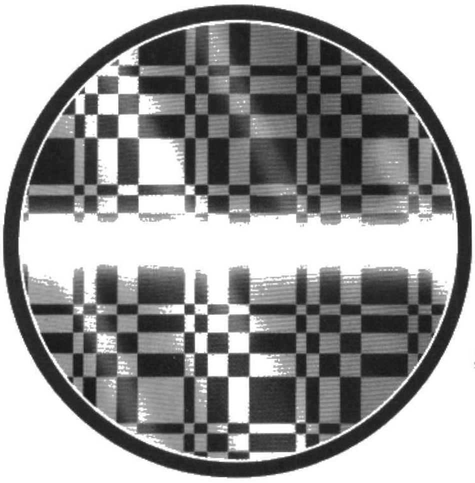
Video Kaleidoscope PCB **Order As 90074 Price £5.49**

Video Kaleidoscope Front Panel Label

Order As 90081 Price £2.29

by Douglas Clarkson

Just as computers are beginning to handle and manipulate images with greater confidence and speed, so the general problems of handling large amounts of image data, both within a computer and across data networks and telecommunications infrastructure, are becoming apparent. While it is possible to send video phone images between a pair of callers, the world's data networks are not able to cope with switching the vastly increased data rates which would be required to be attained.



OPTICAL COMPUTING

INCREASING attention is being directed towards developing optical technology to cope with the problems of routing and handling very high data rates, and also processing of large sets of data now required, for example, in image processing. There is also the goal of developing lightwave optics as an alternative to electronic gate logic processing. It is unlikely, however, that optical technology will rival conventional 'electron' based systems in the area of routine data processing applications – the Pentium processor is fast enough for use in word processing and spreadsheet analysis, and a lot more besides. Also, there is still significant scope to push silicon switching technology even further, as regards density and switch speeds. It is certainly the parallelism and connectivity of light which is driving the technology.

Optical Signal Modulation

The Richness of Light

There is no doubt that data in the form of modulated optical signals will form the future of all high capacity global data networks. A brief review of the 'richness of light' for carrying information and data will reveal why this is so.

In optical computing and photonic switching, a key aspect relates to the modulation of light signals. It is relevant to compare aspects of switching a range of types of signal. If a signal is modulated with the ON time for a minimum of 100 wave cycles and an OFF time for a minimum of 100 cycles, Table 1 shows data rates corresponding to specific wave types.

This is why lightwave technology can deliver such high data rates. It is the basic property of the high frequency of oscillation of the light wave, therefore, that provided it can be appropriately modulated, allows it to support ultra-high data rate transmissions.

Once data becomes modulated into lightwave format, then it is logical and sensible for it to be routed and switched through circuits which can interact directly with the lightwave modulation of the signal. There is intense development activity within the telecommunications industry to develop the technology to be able to switch telecommunications channels carrying high data rates.

The Electronic History Book

Developments with electronic technology have almost without fail, risen to the challenge of coping with demands of increased processing power. The number of transistors on silicon chips has been doubling every 18 months for the past 30 years. It is likely that by the year 2000, a billion transistors will be able to be fabricated on a single silicon wafer. Circuit designs using chips of this complexity will increasingly tend to 'partition' functionality – so that in a circuit or group of circuits, signals are only required in local environments and long path lengths are avoided.

Wave Type	Frequency	Time ON/OFF (100 wavelengths)	Modulation Frequency
Electronic	100MHz	1μs	1MHz
Microwave	10GHz	0·01μs	100MHz
Light	500THz	2×10^{-13}s	5THz

(Note: 1THz = 1,000GHz)

Table 1. Relative data carrying capacity of different signal carrying radiations.

While this increases the complexity of the computational engine, the bottleneck of such systems lies in organising data in and out of these computational elements and using computer instructions to process limited sets of memory. It is principally the much greater opportunities for parallel processing and connectivity with optical technology where the greatest advantages are seen.

Today's most powerful electronic computers can perform in excess of 10,000 million floating point operations per second (flops). Such systems are used, for example, in processing satellite data and in weather forecasting. Since the first computational system, ENIAC, using triode valves, performed at a magical 5,000 additions per second in 1946, there has been an improvement of a factor in excess of 10 million in processing power. By comparison, the speed at which individual logic gates now operate has increased by a factor of at least 1,000. The achievement of increased data processing power has, therefore, largely been achieved more by introducing parallelism into computing processes than by increasing the speed of electronic logic.

The ultimate limit to the speed of electronic computers arises from two considerations – that of the speed of individual logic gates, and the degree of parallelism which can be implemented. In relation to the speed of electronic logic gates, one limitation is the time taken to charge and discharge their electronic structures. The so-called 'brick wall' effect of conventional electronics arises from the fact that although the value of capacitance, C, of gates in very large scale integration (VLSI) systems decreases with increasing scale of integration as areas are made smaller, the resistance, R, of connecting links increases as the conducting channels along which charge flows become smaller. The propagation delays through such circuits are proportional to the product of R and C, which tends, therefore, to remain constant with increased miniaturisation. The speed of propagation of signals in VLSI chips is typically of the order of 1/100th of the speed of light. It is the possibility of using separate

optical technology to break through this timing barrier which makes such alternative technology potentially attractive.

As silicon circuits are operated at higher frequencies, then the circuit paths can approach significant fractions of the wavelength of electromagnetic radiation. Thus, at 100MHz, the wavelength is around 3m. Problems occur as signals interact at impedance terminations and set up standing waves – resulting in the garbling of signal data. Termination of signal lines by low impedance values – around 50Ω, significantly increases rates of power dissipation.

At low frequencies, the current in wires is uniformly distributed across the cross-section of the wire. At high frequencies, however, the 'skin effect' begins to manifest, where current only begins to be conducted at the surface of the wire. This in turn, increases the resistance of the wire and introduces signal distortion. At 1MHz, the skin depth in aluminium is 85μm, and at 3GHz, is 1·6μm. This is a fundamental limitation of electronic connectivity.

Massive Parallelism

It is important, however, to appreciate the fundamental difference between 'electron' based information switching and 'optical' information switching. In the use of electrons as message carriers, currents have to be carried along insulated channels or wires. Essentially, electrons are 'fermions' – strongly interacting particles. There are very real limits as to the packing density of independent current-carrying channels, brought about by their strong mutual electric field interactions.

By contrast, beams of light made up of photons which are boson particles, can be made to pass through each other with no crosstalk. Also, within an array of points of light, individual channels can be placed very much closer together – allowing vastly increased channel densities. A 10×10μm cell size is already utilised in optical technology devices. On a die of side 1cm, with a cell size of 10μm, this allows connectivity to an array of approximately 512×512 elements. In contrast, the electron-based architecture goes to great lengths to keep data components separated from each other.

Such a set of pixels in the format of a 512×512 array, could be simultaneously subjected to a series of logical processes as part of an image processing algorithm. This gives the possibility of achieving image processing speeds significantly greater than are obtainable using conventional serial processors.

Promise of Optical Switching

An early goal of optical computing research, was to develop the technology of fast optical switching using light as the trigger for propagating logic data. This work continues in various centres, and may in time produce radical new switching technologies. Demonstration computers using such logic systems have already been built and successfully operated. Although present demonstration systems of optical switching can be slower than silicon gates, the theoretical switching times of optical systems hold considerable promise for the future.

It is relevant to review some of the early work in this field – principally undertaken at Heriot-Watt University near Edinburgh. At its most fundamental level in optical computing, beams of light can be used as the means to switch optical elements between specific states. A major part of the research initiative at Heriot-Watt and other establishments has been to develop materials which develop so called 'optical bistability' – the property of a material to be switched from being a low to a high (and vice-versa) transmitter of light. This property was unexpectedly observed during work in basic material research in the late 1970s, with the material InSb at liquid nitrogen temperatures and using 10,600nm infra-red CO_2 laser radiation.

Subsequently, materials such as ZnSe have been developed to exhibit such properties at room temperature. Such optical switch elements are in fact, narrow band interference filters, whose structure may be expressed as: [m(HL)][n(HH)][m(LH)] where m and n are integers and H and L are quarter-wavelength

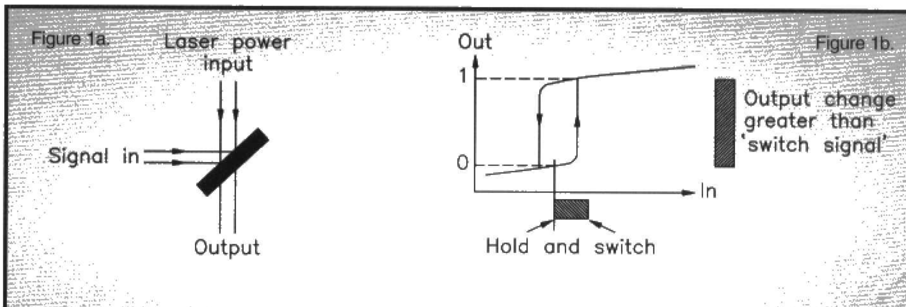


Figure 1a. Design of an OR logic optical switch where the transmitted beam is being switched by the input signal. Figure 1b. Switch cycle of the device.

Material	Area per device (μm²)	Switch and recovery time (μs)	Power per device (mW)	Potential bit rate (gate Hz/cm²)
InSb*	700	0·25	0·6	10^{11}
ZnSeNLIF*	20	10	4	10^{9}
Liquid Crystal* (K15)	500	1,000	0·02	10^{9}
GaAs (AT&T)	75	0·02	4	10^{11}

Table 2. Characteristics of a range of early optically bistable materials. (*denotes investigated at Heriot-Watt University).

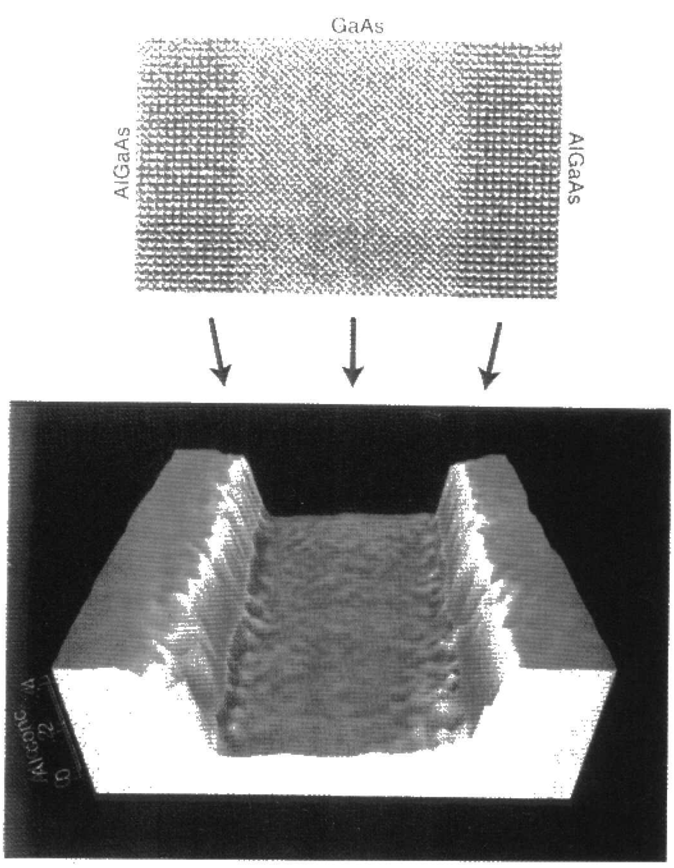


Photo 1. Atomic structure of FET-SEED device. (Courtesy of AT&T Bell Laboratories.)

thicknesses of high and low refractive indexes, respectively, for the wavelength of light used.

Such filters are designed to operate on a specific wavelength of laser radiation, such as the 514nm line of argon. With the switch inactivated (low transmission state), uptake of energy by the filter produced, for example, by absorption of laser radiation, shifts the absorption edge from below 514nm upwards, allowing the device to transmit higher levels of incident radiation. While the mechanisms of such switching are therefore thermal, they result in a change in the optical properties of the device. The significance, however, is that the switching of elements can be undertaken with free space propagating light beams with significant opportunities for massive parallelism of function.

Extensive investigation has been undertaken at Heriot-Watt, of logic transitions of discrete optical switch elements. In early development work, a typical OR gate structure implemented using such technology would have a main input channel (whose transmitted beam would represent the output of the device) and a separate switching signal input, which would act to switch the device from an 'off' state (low transmission) to an 'on' state (high transmission). Such transmission switches fabricated using ZnSe as the high refractive index material in the NLIF sandwich typically have a contrast ratio of 2:1 between high and low transmission states. Devices could also be driven in reflection for NOR and NAND gate action. Figure 1a shows the design of an OR logic optical switch where the transmitted beam is being switched by the smaller input signal. Figure 1b shows the switch cycle of the device.

Development has been directed to reducing device switching times and power consumption, while increasing fabrication density. While the concept of optical computing conveys the impression of light interacting with light at the speed of light, the quasi thermal interaction at device level is limited by factors such as heat capacity of substrate, thermal conductivity and power density of incident radiation. Most implementations of optical devices are in fact, a compromise between speed, power requirements and fabrication density. Switching speeds can be improved using higher switching levels or smaller device areas.

In the design of systems of optical logic, it is necessary to implement so called restoring logic. Thus, the high state transition of one switch should be sufficient to act as the switch signal for the following gate. In practice, the signal levels are usually set at around 90% of threshold, and the output level rises about 20% above that necessary to switch the following gate. The systems of interconnection must also ensure that losses do not reduce signal levels below those at which successful transitions would occur.

In early phases of such work at Heriot-Watt University in the late 1980s, conventional AND, OR, NAND and NOR logic gates were also demonstrated using optical logic gates. The team at Heriot-Watt in the late 1980s designed more advanced devices, including memory units, clocks, a full adder and a programmable processing stage. These units are clearly the essential building blocks for a self-contained optical computer.

Table 2 illustrates characteristics of some optically bistable materials.

The potential bit rate (Hz/cm^2) factor assumes a maximum power dissipation of 10W/cm2. Sapphire, with its high value of thermal conductivity, is an ideal material to use as a heatsink substrate. Developments in optical switching will naturally be very much linked to fundamental developments in materials science.

This stage in optical switch technology was perhaps analogous to the state of semiconductor electronics with the discovery of the transistor in 1947. Since then, electronic component fabrication has developed considerably and no doubt, considerable advancements lie in wait also for optical systems. The improvements sought will be to reduce the power consumption of each switch, reduce the time for switch/recovery mode and also maximise fabrication density. It should be noted that the initial approach at Heriot-Watt to optical computing was 'all optical' – logic switching involved interacting light beams.

Optical Engines

While optical switching provides for alternative logic switching mechanisms, it offers new possibilities for computer architecture. The conventional mode of operation of electronic computers is via the modified Von Neuman finite state machine. Logic controls the manipulation of data which is accessed through an address bus mechanism. This conventionally allows only 8, 16 or 32-bit wide extents of data to be accessed and manipulated by specific processor instructions. Using the greater interconnect possibilities of optical computers, logic functions can be made to simultaneously access extensive tracts of memory in the so-called classical finite state machine, with parallel access to all memory elements. The optical solution of a bus structure via lens matrices, however, overcomes this basic processing limitation, making possible alternative logic/memory designs. It is these emerging concepts of signal interconnections and high levels of parallelism which could lead to the development of considerably faster computing engines, of radically different designs.

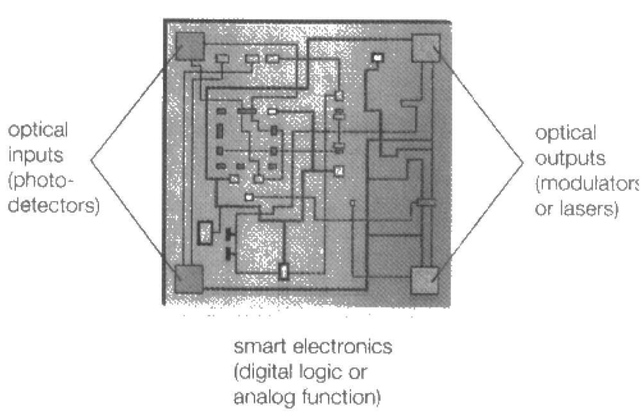
Smart Pixels
The AT&T Bell Laboratories Approach

At AT&T Bell Laboratories in the USA, the focus of attention in optical computing technology was on developing self-electro-optic-effect (FET-SEED) devices. One configuration, for example, contains 400 transistors and 96 optical inputs or outputs. Acting as a switch controlled by light beams landing on the chip surface, input beams are switched to output beams in accordance with logic of input beams of light.

The FET-SEED effect rises out of the ability of an electrical voltage to change the optical transmission properties of quantum-well structures formed from ultra-thin layered semiconductor structures. The physical effect utilised is termed the Stark effect. The ultra-thin layers can be a mere 40 atoms thick. The atomic structure of a FET-SEED device is shown in Photo 1.

AT&T has generally pursued the approach of the smart pixel in optical computing and switching applications. Photo 2 indicates the general structure of a smart pixel, with cells which typically comprise of two optical inputs which can act as logic or data input, and two optical outputs which can act as modulators or lasers.

In connective optical structures, an array of 'smart pixels' could be used as the plane of termination for a complex sequence of



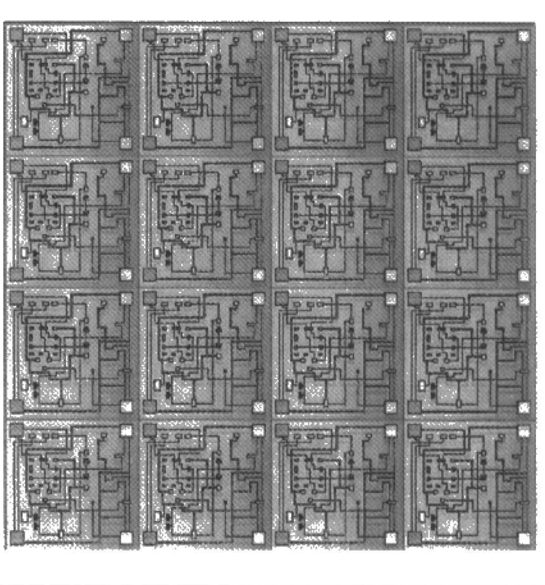


Photo 2. General structure of a smart pixel, with cells typically comprising of two optical inputs which can act as logic or data input, and two optical outputs which can act as modulators or lasers. (Courtesy of AT&T Bell Laboratories.)

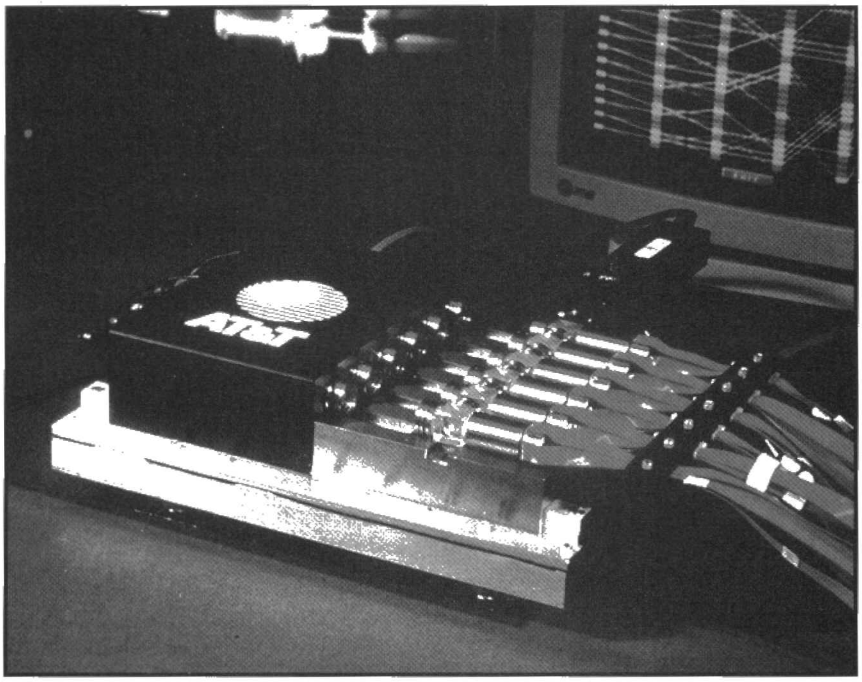


Photo 3. Component of an experimental photonic switching system developed by AT&T Bell Laboratories, which handles 2,048 parallel channels of information. All data in and out is communicated by light beams, and internally more than 60,000 light beams replicate the switching functions. (Courtesy of AT&T Bell Laboratories.)

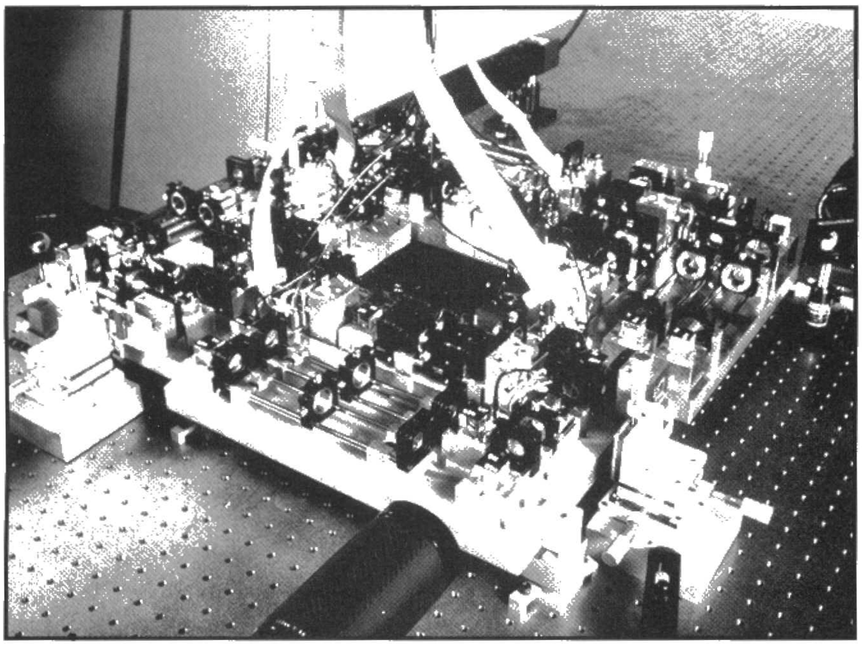


Photo 4. Indicates an experimental optical digital computer developed at AT&T Bell Laboratories around 1990. The unit comprises essentially arrays of optoelectronic logic gates. (Courtesy of AT&T Bel Laboratories.)

parallel optical data processing units. The design of such devices allows parallel image processing, where information about 'local' conditions can be used to determine how image data is processed. This allows for increased speed of processing.

Using such FET-SEED technology, a large free space optical system was built in early 1994 at AT&T Bell Laboratories, which used more than 60,000 light beams to switch more than 1,000 channels of information. While the system was in fact, slower than conventional telecommunications systems, it demonstrated the potential of the technology. Subsequently, data rates per channel have increased to 155M-bit/s in field tests to more than 650M-bit/s in laboratory experiments. It is anticipated that such technology will attain total switch rates of between 100 billion to one trillion bits per second (bps) of data, distributed over as many as 1,000 high-speed data channels.

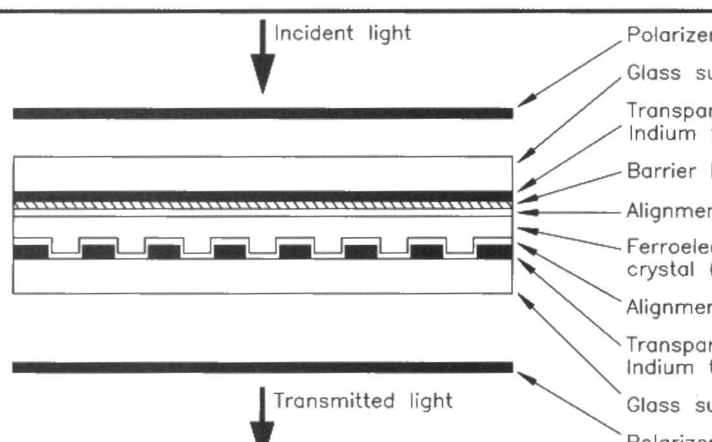
Such high data throughput rates will be required to cope with the rapidly increasing capacity of communications lines. Where a conventional large telephone exchange may switch 100,000 phone calls and process a total capacity of 5 billion bps, standard television signals require between 100 to 1,000 times as much information as normal telephone calls. It is in this role of switching high capacity lines that photonic switching will find its first application.

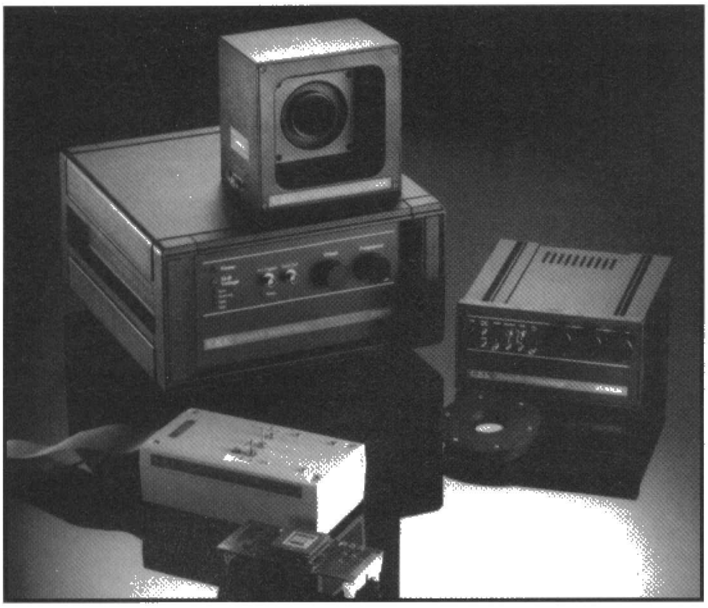
Photo 3 shows a component of an experimental photonic switching system developed by AT&T Bell Laboratories around 1994, which handles 2,048 parallel channels of information. All data in and out is communicated by light beams and internally, more than 60,000 light beams replicate the switching functions. Photo 4 indicates an experimental optical digital computer, developed at AT&T Bell Laboratories around 1990. The unit essentially comprises of arrays of optoelectronic logic gates.

Spatial Light Modulators

In the processing of optical data, another key component is a spatial light modulator (SLM). Light in the form of plane wavefronts is passed through an array of optical elements, which can either change the relative amplitude or phase of the transmitted wavefront. One form of SLM consists of effectively two sheets of glass, between which is held an array of liquid crystal elements which are in turn, switched by electronic signals. In this configuration, shown in Figure 2, electrical connections to control the liquid crystal elements are transparent. There is, however,

Figure 2. Basic design of a glass plate technology Spatial Light Modulator (SLM). Transparent electrical connections switch the ferroelectric liquid crystal cells to either alter the phase or amplitude of transmitted light. (Courtesy of CRL Smectic Technology Ltd.)





Left: Photo 5. Family shot of CRL Spatial Light Modulators with associated drive circuitry. 2DX320 (upper left); Bistable Optically Addressed SLM (right); SBS 256 (lower left). The Silicon Backplane device is, therefore, significantly more compact than the other devices. (Courtesy of CRL Smectic Technology Ltd.)
Below: Photo 6. View of a familiar face, to indicate grey scale tones with the SBS 256 silicon backplane device. (Courtesy of University of Edinburgh)

advantage in moving the electronic logic elements controlling each pixel closer to the site of the pixel. This is achieved in the Silicon Backplane spatial light modulator, where elements can be switched at faster data rates. Such systems have been extensively developed at the University of Edinburgh.

In the selection of liquid crystal substances, the fastest switching speeds are achieved using ferroelectric liquid crystals. These have the advantage that they can be 'toggled' by electrical drive signals to remain in one of two states, even after the switch pulse has been applied and removed. A range of such SLMs have been developed by CRL Smectic Technology, a Division of Thorn EMI. The 2DX320 SLM, with 320×320 pixel array, was launched in February 1994 and later that year, the SBS256, a 256×256 silicon backplane device was announced. Such SLMs are being used extensively in optical computing and switching applications. Photo 5 indicates the range of CRL spatial light modulators. The Silicon backplane device has the advantage of being the most compact.

Photo 6 indicates the view of a familiar face, as modulated by the Silicon backplane device. The rapid switch rate of the liquid crystal pixels allows finer definition of grey scales in the processed image. Photo 7 shows a CRL Bistable Optically Addressed Spatial Light Modulator in laboratory use. Such a device can be used to convert a non-coherent image source into a coherent image source as a stage in optical processing of data.

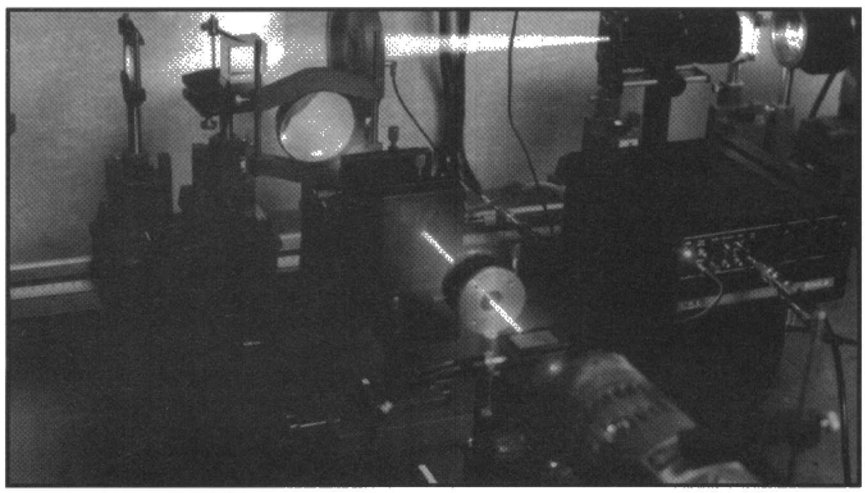


Photo 7. CRL Bistable Optically Addressed Spatial Light Modulator in laboratory use. Such a device can be used to convert a non-coherent image source into a coherent image source. (Courtesy of CRL Smectic Technology Ltd.)

One of the principle applications of an SLM is for switching elements in an input array to elements in an output array, after the general principle indicated in Figure 3, which shows an input array with N sources being expanded into an SLM with N×N pixels, and then recombined in an output array with N elements. In the example of a 16×16 array of input signals, these are expanded by optical elements such as a Dammann grating, so that the data is expanded 16 times onto a 256×256 array on an SLM. The SLM can be configured by suitable switching of its individual elements and recombination of the image to an output 16×16 array. The SLM is therefore, a mapping device. As an example of the possible modes, Figure 4 indicates possible

Figure 3. Mapping of N input array to N output array via an SLM with N×N pixels.

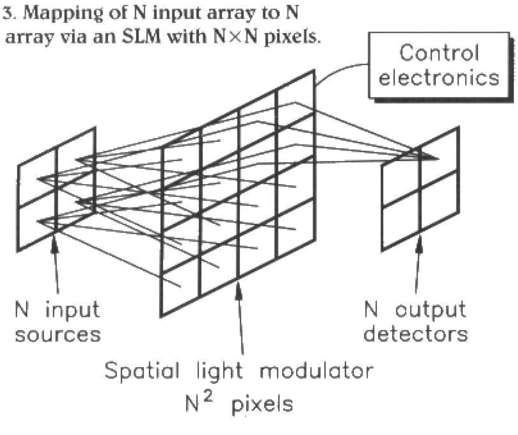


Figure 4. A selection of possible mappings of input field (0 to F) channels to output channels.

Original

0	1	2	3
4	5	6	7
8	9	A	B
C	D	E	F

#1

4	5	6	7
8	9	A	B
C	D	E	F
0	1	2	3

#2

1	2	3	0
5	6	7	4
9	A	B	8
D	E	F	C

#3

0	4	8	C
1	5	9	7
2	6	A	E
3	D	B	F

#4

0	1	2	3
0	1	2	3
0	1	2	3
0	1	2	3

output states for a 4×4 input matrix. Four specific data translations (input channel to output channel) are shown.

Optical Plumbing

In optical technology, new building blocks are being developed to exploit the capabilities of such complex and sophisticated devices as spatial light modulators. It is often required to implement a 'one-to-many' connectivity in optics, where the output of a single optical fibre is replicated a significant number of times. This can be undertaken if the output of the fibre is coupled into a Graded Index (GRIN) lens to provide a Gaussian beam profile, and this beam profile is in turn, passed through a Dammann grating. Figure 5 shows a typical Dammann grating on the left, and right of it is the output pattern of a 8×8 ray generator. The refractive index of such minute GRIN cylindrical lenses decreases with radius according to a specific mathematical formula:

$$n = \frac{no\,(1 - A \cdot r^2)}{2}$$

Where n is the refractive index, r is the distance from the centre of the lens and A is a constant of the lens material.

This conveys on the lens the property of a Fourier transform lens, enabling a monomode fibre output to be transformed by the GRIN lens to create a collimated Gaussian beam for fan-out by a hologram device or Dammann grating. Arrays at least as high as 128×128 have been demonstrated using these techniques – i.e. from one Gaussian input, an array of 128×128 output points has been established. Acting in reverse, a second GRIN lens can create a fan-out of replicated Gaussian beams for coupling to output fibres. Problems of fabrication, however, introduces variability of resulting outputs from element to element, and invariably, the central 'straight through' has a higher output value than the other elements.

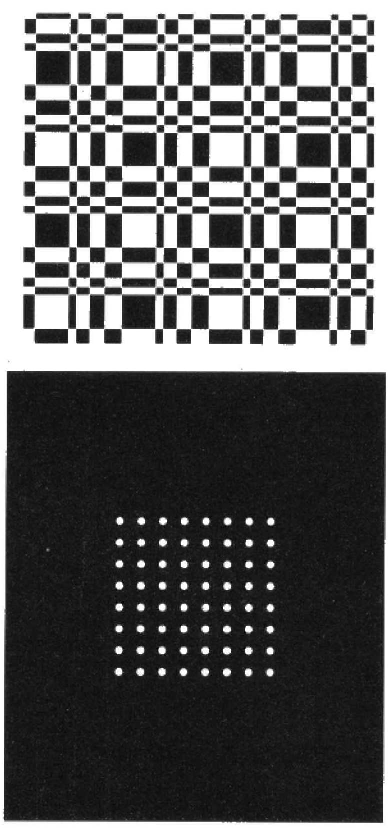


Figure 5. Typical Dammann grating (top) which replicates a single Gaussian beam to an array of 8×8 outputs (above). (Courtesy of CRL Smectic Technology Ltd.)

Summary

Optical computing has now made available a rapidly expanding range of building blocks available commercially, and this is allowing significant growth in associated applications. The 1990s will see new developments in this field, both in the refining of existing technology and discovery of wholly new ways of harnessing the great potential of light to transmit data and undertake rapid computational tasks. At the same time, this is creating a demand for technicians, engineers and scientists with skills in optical technology, to meet the challenges ahead.

Contacts

CRL Smectic Technology,
Dawley Road,
Hayes, Middlesex UB3 1HH.
Tel: (0181) 848 6428
Fax: (0181) 848 6565

Public Information Department,
AT&T Bell Laboratories,
Holmdel, NJ 07733, USA.

Department of Physics,
Heriot-Watt University,
Riccarton, Edinburgh EH14 4AS.

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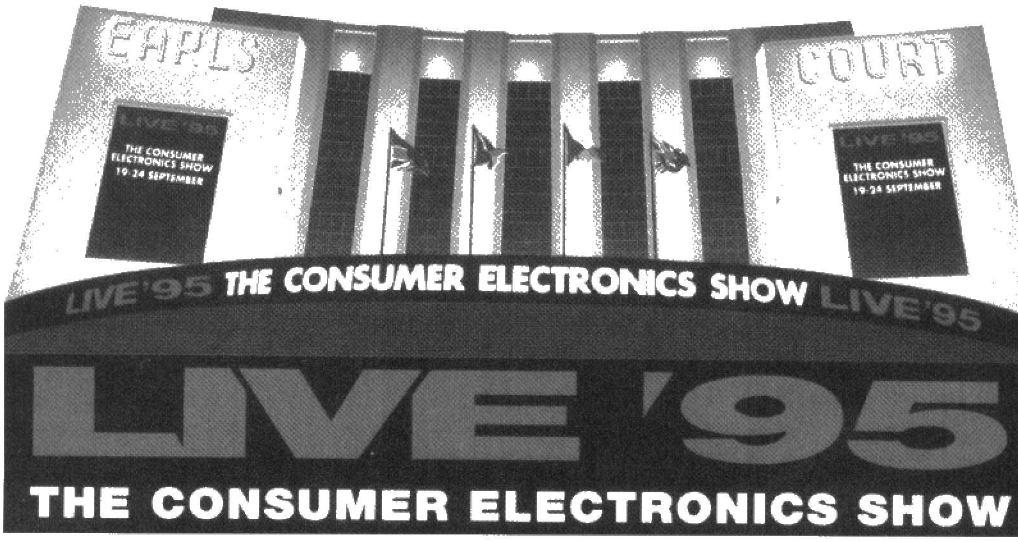


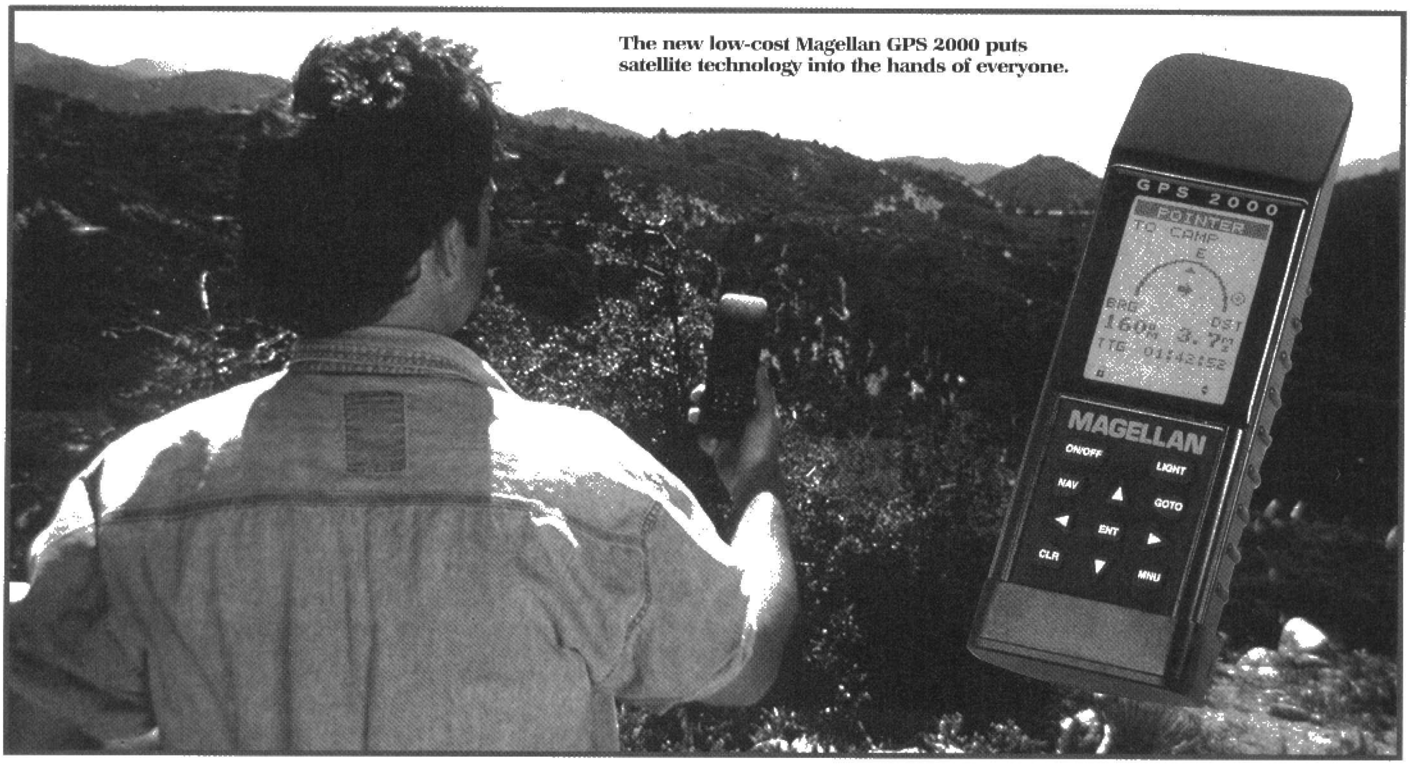
YES! Live '95 – The Consumer Electronics Show moved back into Earls Court in London, for one week in September, the Earls Court Exhibition Halls were alive with the sound of Hi-Fi, games and computers, musical instruments, and in-car entertainment. The halls were also vibrating with film and video projections, multimedia and Internet, camcorders and cameras.

Naturally, Maplin Electronics was there, adding to the general ambience with a stunning array of NEW products, components and projects, many of which are highlighted in the equally stunning new Maplin Catalogue, and being shown in public for the first time. In particular, a new range of protection products, including tracking and child-watch systems. This year, it was possible to purchase for immediate take-away, a wide range of Maplin products from the stand, including cables, connectors and components, or to order any item from the new Maplin Catalogue for same-day dispatch.

Maplin/Live Keep on the Move Contest

New products apart, the Maplin stand was pulling in the punters, thanks to the exciting Maplin LIVE '95 contests. Under the banner, 'Maplin Keeps You On The Move', there was the chance to win a Magellan GPS 2000 Satellite Navigator. The Magellan System puts satellite technology into the hands of everybody. Whether you are walking, climbing, fishing, cycling or simply lost, the Global Positioning System receiver will give your precise position, direct you to a predetermined landmark, or show you the way home. Great fun for all the family, the Magellan GPS 2000 can be used anywhere in the world, by entering the landmark for places you want to reach, you receive all the information needed for your route. It will show the speed you are travelling, the distance to your destination, and how long it will take to get there. Just imagine – the weather closes in and you don't know the way back to the car, track or ski lift. Because the GPS 2000 has automatically stored your position every 10 minutes, you can simply select the backtrack facility and it will guide you safely back the way you came. About the size of a mobile phone, the Magellan utilises a constellation of 21 satellites orbiting at 11,000 miles above the earth to locate its position. Now this star-wars technology is available from Maplin at £199.99.

Somewhat closer to home in navigation terms, Maplin had three Traffic*master* YQ units, plus a seven month air time card as the second prize for their LIVE '95 contest. The YQ comes in a pack which includes everything a user requires to install in their car. The Traffic*master* gives live pic-



The new low-cost Magellan GPS 2000 puts satellite technology into the hands of everyone.

tures of holdups and problems on all UK motorways and over 400 miles of trunk roads. The system uses infra-red sensors mounted on motorway bridges about every two miles. When the traffic speed under a bridge drops below 30mph, the sensor transmits a signal to the Traffic*master* National Traffic Data Centre. The data is then transmitted to each YQ using a radio signal, and gives details of holdups (caused by accidents, breakdowns, roadworks and so on) including traffic speed and direction.

The YQ also gives useful information, including the latest weather reports, news headlines, plus details of long-term roadworks and other potential delays throughout the motorway network. In addition, the YQ can be used as a personal messaging system – an extremely valuable service, at no extra cost (the incoming callers pay a small charge). The cost of the basic unit is £149.99 (including one months subscription), and the fee for six months is £60.

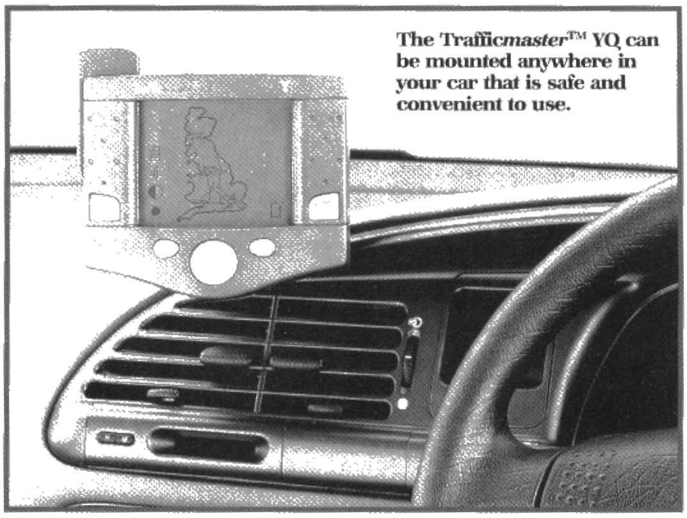
To help ensure that you didn't get lost on your way out of the Earls Court Car Park or local station, there were also six runner-up prizes of the famous Silva 26S compass. Priced at £17.96 each, the compasses come with full instructions. Note: All prizes are featured in the new Maplin Catalogue.

And talking of contest prizes, a highlight of LIVE '95 was the stunning *ELECTRONICS – The Maplin Magazine* contest, which featured a first class return trip from London to Paris for two aboard the sensational Eurostar train, plus two return car tickets for Le Shuttle and numerous tickets to visit the Eurotunnel Exhibition Centre at the UK Channel Terminal. Not surprisingly, the entry response has been stunning.

In addition, Sir Clive Sinclair was on the Maplin stand, demonstrating his latest high-tech invention, the Zeta, which transforms any bike from pedal power to electric power, to provide effortless, enjoyable cycling.

Beyond Reality

But what of the over 200 exhibitors at LIVE '95? A must for auto freaks was a visit to the Automobile Association stand, where a 'concept car of the future', a Lotus for the 21st Century, was lined up. For photography buffs, BPIA ran a special 'Photo Live' session, featuring the TV Gladiators. In fact, the Gladiators popped up all over the place, with a bevy of curvaceous team members



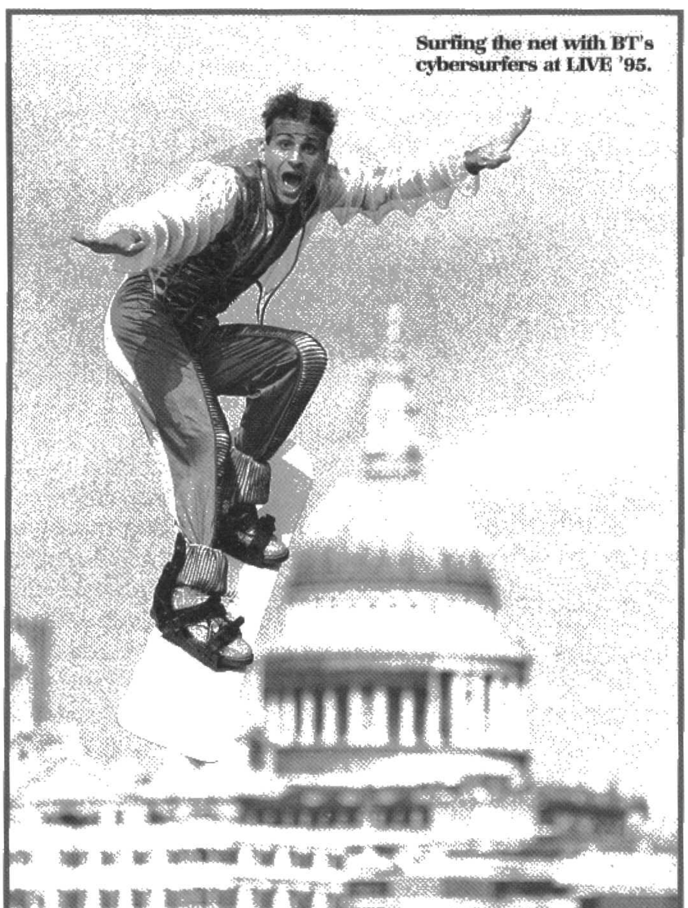
The Traffic*master*™ YQ can be mounted anywhere in your car that is safe and convenient to use.

demonstrating their charms on the Motorola stand. Here, for those still thinking about joining the mobile phone club, a visit to the Motorola stand was highly worthwhile. The company introduced a high-performance lithium battery, which provides a remarkable amount of power – up to 190 minutes talktime or 39 hours of standby time. The new Motorola mobile phone 'Flare' was on show, as well as the 'Benetton' pager, which incidentally, will be an *ELECTRONICS* contest prize in a future edition. Motorola also had a high-performance personality on their stand, Frank Bruno, who was well able to keep the crowds at bay.

Meanwhile, Leica showed what they claimed to be the smallest camera in the world, plus the most exotic – a gold-plated mini job. KEF Audio demonstrated their newly developed home theatre speakers system, a revolutionary loudspeaker technology with an ultra-wide listening window.

Interactivity – the Theme of the Show

There was no shortage of Internet and interactive networks on show. BT launched an interactive games network, using standard phone lines and a home computer and modem. Called 'Wireplay', BT were recruiting visitors to beta-test the system early next year.



Surfing the net with BT's cybersurfers at LIVE '95.

Wireplay will allow users with a compatible game on their PC to access the system via a modem. Once logged on, the user will enter the Wireplay open forum, and be able to challenge and play other players, or even join a league and play in teams.

I Saw it on the Internet

3D displays were being staged by such companies as Sharp and Sanyo, while on the practical front, Envision from Olivetti converts a TV into a PC. While on the Internet front, Demon Internet (whose bevy of show-girls were, unsurprisingly, dressed as demons) made the startling announcement that it can offer local call access for 100% of the UK population. Yamaha also revealed some major surprises, including a desktop system which combines with multi-media technology to give home enthusiasts the ability to compose music videos and record them onto their own CD. Sony were also making a song and dance about its super-cool, technologically stunning Play Station. A visit to the Nokia stand could have been rewarding – a trip to the Metropolitan Museum of Modern Art in New York. Nokia is using white noise to build invisible partitions, so each product can be appreciated in its own right.

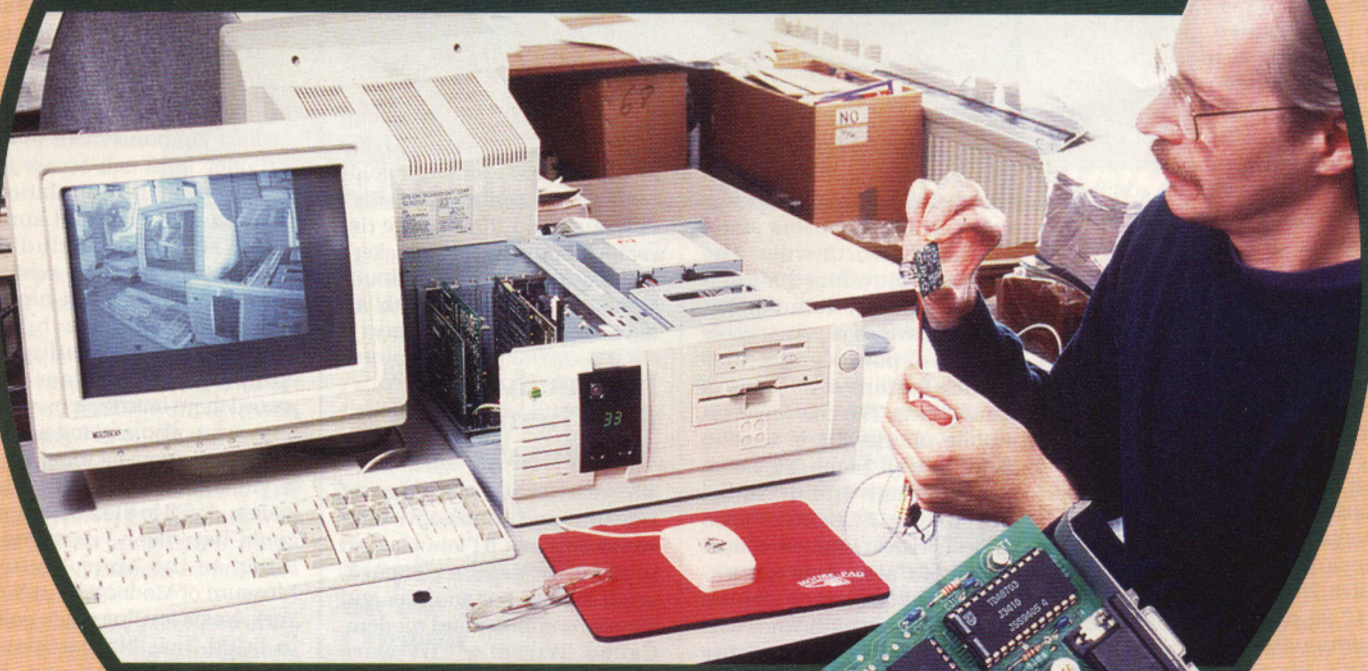
For those who demand noise and hands-on action, Optimusic, based in the Capital Entertainment Zone, created sound by means of reflecting lightbeams and computers. How do they do it? Well, the components are supplied by Maplin – enough said. In terms of size and quality, the Sony stand took a lot of beating. In fact, it was very much an exhibition within an exhibition. The stand covered over 3,000m^2, 700 TVs, 16 miles of AV leads, 36 tonnes of steel, over 2,000 electrical outlets, and over 1MW of light. The Sony stand also contained the biggest TV wall in the world, with 640 monitors, and the stand was so large, that a 9m high Michael Jackson statue fitted comfortably inside.

New products apart, there was no shortage of baseball caps, badges, CDs, key-rings, lighters, and much, much more for the keen collector. Best coffee on stand? At Mitsubishi, who were launching their new GSM mobile phone. Alternatively, you could have surfed the net at BT's Internet Cafe. Without doubt, the place to chill out and surf out was LIVE '95.

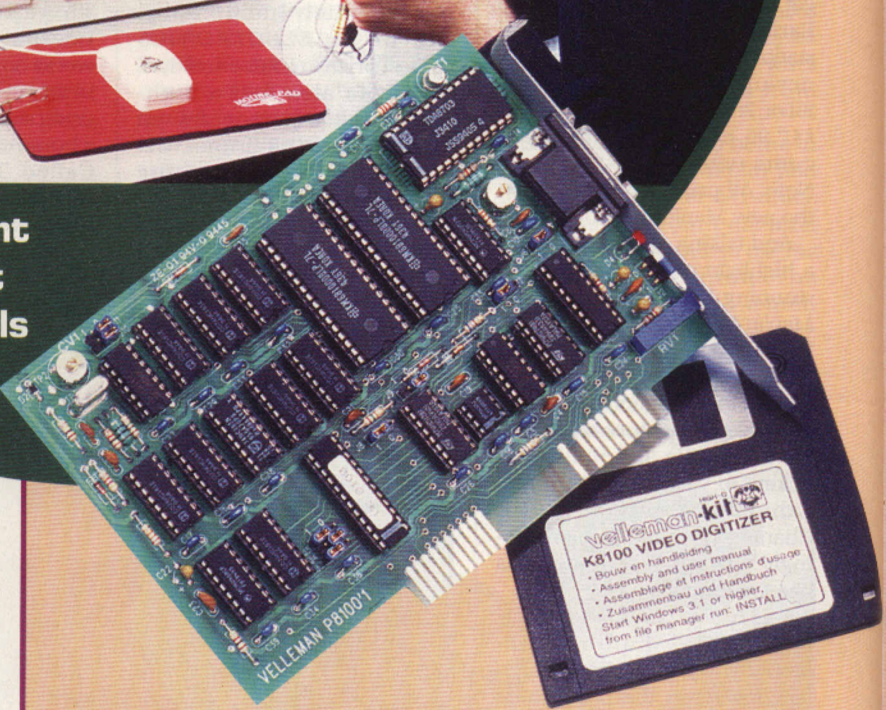
2
PROJECT RATING

KIT AVAILABLE (95010) Price £139.99 G1

VIDEO DIGITISER



Text by Maurice Hunt
Technical support by Nigel Skeels



Right: The assembled PCB and supplied software disk.

FEATURES

- Black and white (monochrome) or colour digitising
- Easy to construct and operate

APPLICATIONS

- Home video storage/processing
- Close-circuit TV (CCTV) security camera systems
- Presentations

This superb project is a real-time Video Digitiser card intended for use with IBM compatible PCs fitted with a VGA or higher grade monitor. The system converts video signals into digital data that can be processed by the PC, and therefore enables you to view and store pictures sourced from either a video camera, composite black and white (monochrome) video, or a colour RGB signal, on a PC. This then allows you to use or modify the stored images as you require. Software is included in the kit, which operates under Windows 3.1 or higher operating systems. The software incorporates operating and construction details for the kit, are in a choice of four languages – English, Dutch, French, and German, and in addition, conventional written instructions are provided. Pictures may be digitised in black and white or RGB colour from either TV, camera, or tape sources.

Specification

System requirements:	IBM-compatible PC with 286 or higher processor
	VGA or higher video card
	Spare expansion slot
	Windows 3.1™ or higher
Black and white images	
Resolution:	512 × 512 pixels
Grey levels:	256
Sampling rate:	10MHz
Input signal:	Composite PAL video (15·625kHz line frequency)
Video input level:	1V Pk-to-Pk
Output file format:	TIFF (8-bit)
Colour images	
Resolution:	512 × 512 pixels
Colour input signal:	RGB (1V Pk-to-Pk)
Number of colours:	16·7 million
Output file format:	TIFF (24-bit)

THE Video Digitiser card is capable of capturing frames from live composite video signals with 256 grey levels, and 24-bit full colour pictures from still image RGB signals. The card digitises both even and odd fields of the incoming signal, and the interlacing is managed by the software program. The output file is in the form of TIFF (Tagged Image File Format) files. The output files may be processed further by almost any graphics program that runs under MS-DOS™ or Windows™, the recommended graphics program being 'Paint Shop Pro', which is shareware. This then enables you to enlarge images, distort them, and recolour them as you desire. You can then obtain a hardcopy of your handiwork if you wish, by printing the stored, digitised images onto paper, assuming you have a suitable printer connected to your PC. The project thus provides the scope for many hours of amusement, as well as having more serious uses, such as in security monitoring systems; the project will work with the Maplin range of charge-coupled device (CCD) sub-miniature video cameras, in the case of the monochrome version (AY16S/DN48C), this allows images to be seen in the dark, thanks to the camera being infra-red sensitive and incorporating built-in infra-red illumination of the scene.

Circuit Description

Refer to the block diagram shown in Figure 1, and the circuit diagram given in Figure 2. The composite video signal is applied to the digitiser card via the input connector J1-1. The video signal follows two paths – one leads to the A/D converter IC3 (a TDA8703) via a colour trap (formed by R13, L2, and C37), and the black level restoration circuit (C10 and V1). The other path leads to the synchronization separator, IC1, an LM1881, which extracts the horizontal and vertical sync from the composite input signal. In addition, it supplies an odd/even frame indication signal and burst-gate/black level timing information on pin 5. The burst-gate signal is fed to the base of transistor V1, that switches on during the pulse and restores the black level of the video signal to the level adjusted by preset R15. Table 1 shows connection details for the 9-way D-type input connector.

A/D Converter

The video signal brought into IC13, an 8-bit flash A/D converter, is converted on receipt of the clocking pulse from the 10MHz oscillator formed around IC5f, into an equivalent digital output on pins D0 to D7. These lines are connected to the data inputs of two 128K-byte memory chips, IC14 and IC15.

Memory

The memory address at which each sample is stored is determined by the counters IC16 to IC20. These are connected in series, and are clocked at the same rate (10MHz) as the A/D converter. The selection of which memory is active is controlled by the state of the output pin 13 of IC20. When low, IC14 is forced active by taking its CE1 pin low, and IC15 is forced inactive by taking its CE2 pin low. When high, IC14 is forced inactive and IC15 active. Sampling takes place on the low-to-high transition of the clock signal, and the conversion is completed in about 10ns. When the clock goes low, the data is transferred to the selected capture memory.

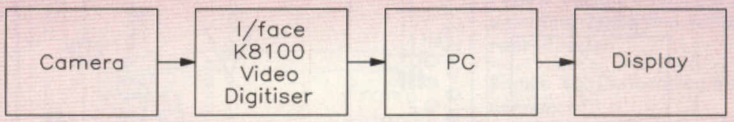
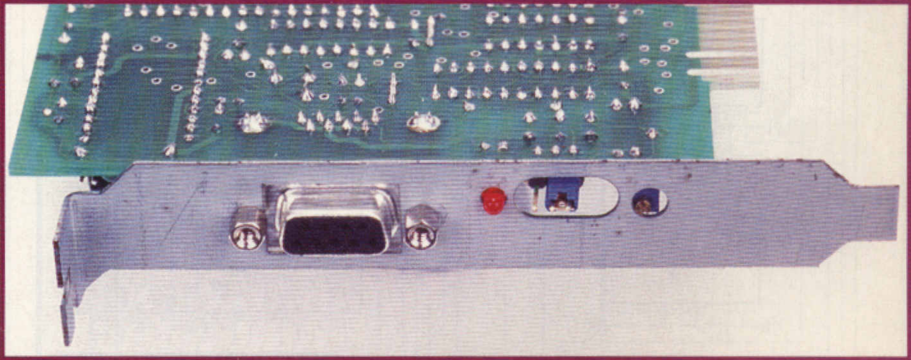
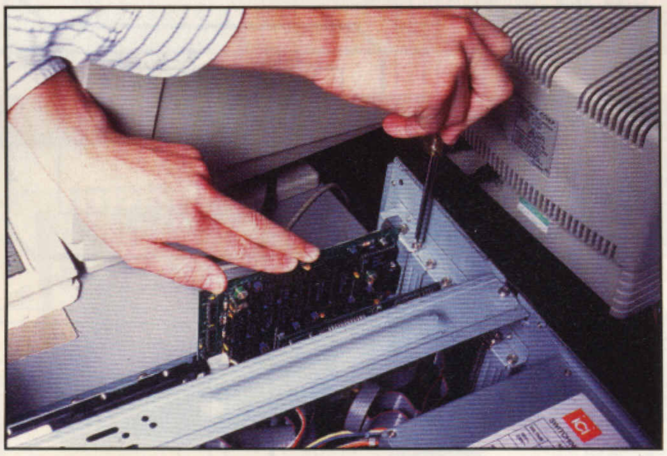


Figure 1. Block diagram of the K8100 Video Digitiser system.



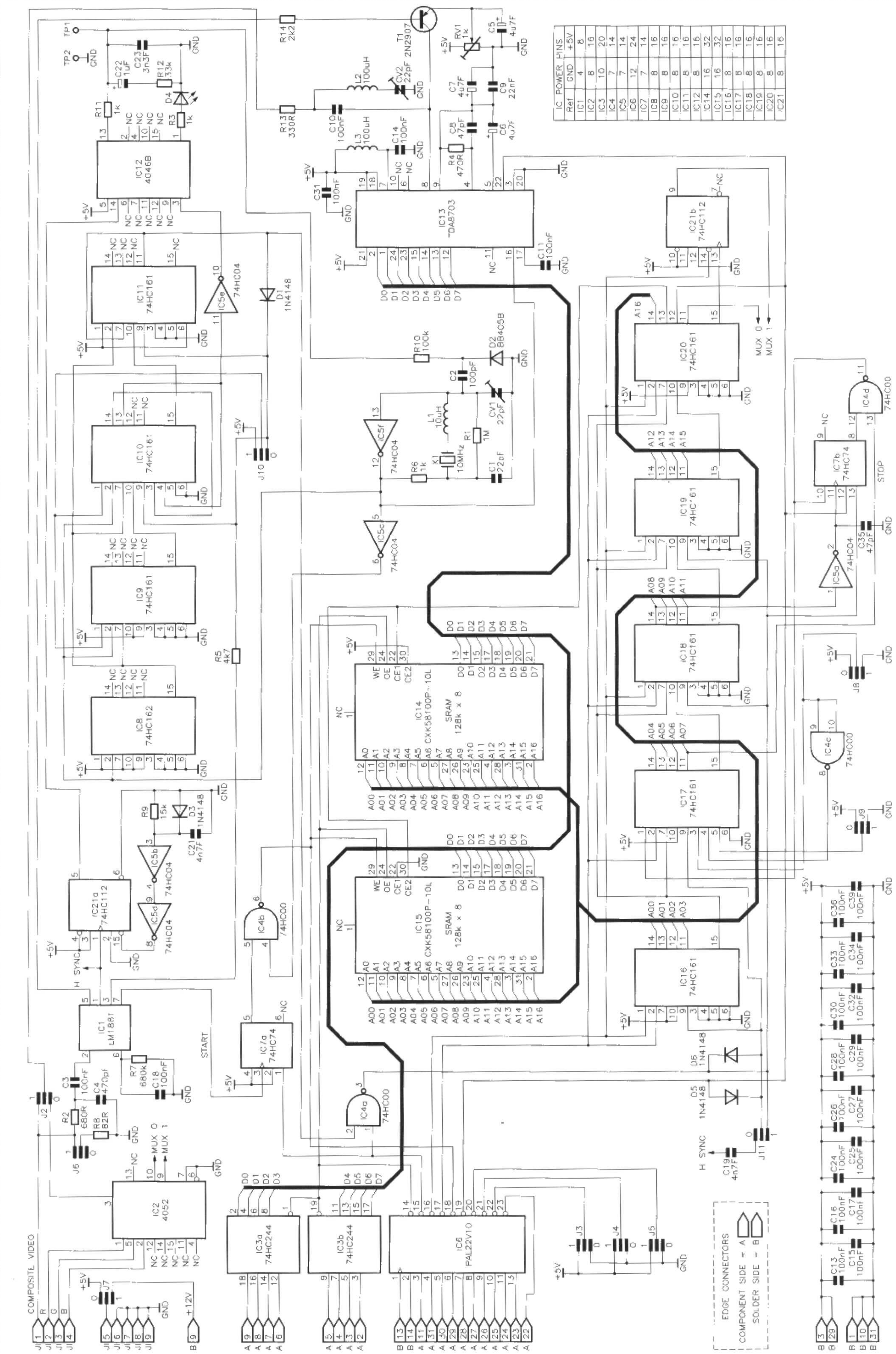


Above: Close-up of PCB mounting bracket showing connectors.

Left: The Video Digitiser card being plugged into a PC.

PIN	SIGNAL
1	Composite video input, 1V Pk-to-Pk
2	R (red), 1V Pk-to-Pk
3	G (green), 1V Pk-to-Pk
4	B (blue), 1V Pk-to-Pk
5	+12V (or +5V) output
6-9	GND

Table 1. 9-way D-type connector pinout.



IC POWER PINS		
Ref	GND	+5V
IC1	4	8
IC2	8	16
IC3	10	20
IC4	7	14
IC5	7	14
IC6	12	24
IC7	7	14
IC8	8	16
IC9	8	16
IC10	8	16
IC11	8	16
IC12	8	16
IC14	16	32
IC15	16	32
IC16	8	16
IC17	8	16
IC18	8	16
IC19	8	16
IC20	8	16
IC21	8	16

Figure 2. K8100 Video Digitiser circuit diagram.

Capture

To initiate the capture, the software first resets the address counters IC16 to IC20, and the START D-type flip-flop IC7a, by writing to the I/O address of the card. The START D-type flip-flop is set, and the clock signal is allowed to pass through NAND gate IC4b to the memories' write enable pins and to the address counters. The capturing starts when the output 11 of the line counter IC11 goes high, and allows the PE pins of the address counters IC16 and IC17 to go high. This takes place 32 lines after the rising edge of the ODD/EVEN signal from IC1. The vertical sync pulse from IC1 resets the line counter IC11 at the beginning of each frame. The period of one horizontal line is 64μs. The whole line is not digitised because of the limited memory available, hence, 512 samples are digitised per line. This is achieved by the STOP flip-flop, IC7b, that generates a reset pulse to IC17 on every 512th sample. IC16 needs no reset, because all of its outputs are at logic 0 at that time.

Reading the Memory

During the first 131,072 (128K) counts, memory IC14 records the data. When pin 13 of IC20 goes high, IC15 records the next 131,072 data samples. On count 262,144 (256K), the output pin 12 of IC20 goes high, and will remain so for the next 262,144 counter steps. This time, the A/D converter is disabled (outputs are in a high impedance state), and the START flip-flop IC7a is reset. The clocking signal is no longer routed to the counter chain via IC4b and IC6. Instead, the clocking can now come from the PC, via IC6. Every low state of the I/O read (IOR) pulse from the PC enables the I/O buffers IC3a and IC3b, and the data outputs of the memory (IC14 or IC15 via the OE line); the memory content can then be read by the software. The address counters are incremented on the rising edge of the IOR pulse. The PC can step the counters through all 262,144 addresses, and read the memory contents at each address.

When the contents of the memory is read, the output 12 of IC20 goes low, which enables the A/D converter, and allows a new start of the digitising at the next rising edge of an ODD/EVEN signal from IC1. The highest bits of the

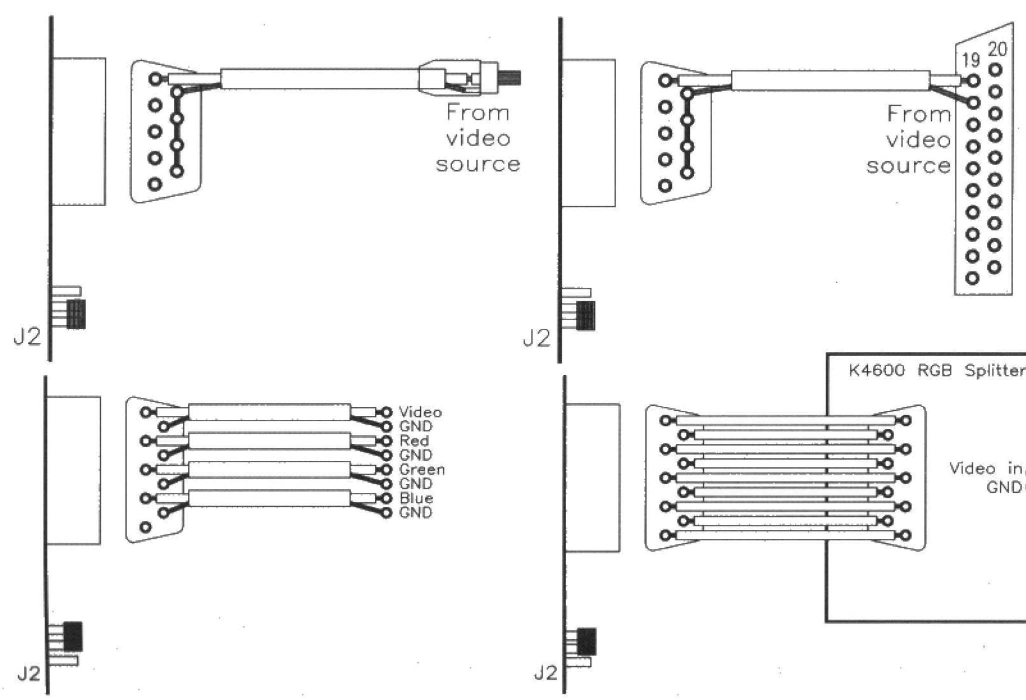


Figure 3a. Connecting a normal signal for black and white reproduction.

Figure 3b. Connecting a SCART connector.

Figure 3c. Connecting a colour RGB signal.

Figure 3d. Connecting to the K4600 RGB Splitter.

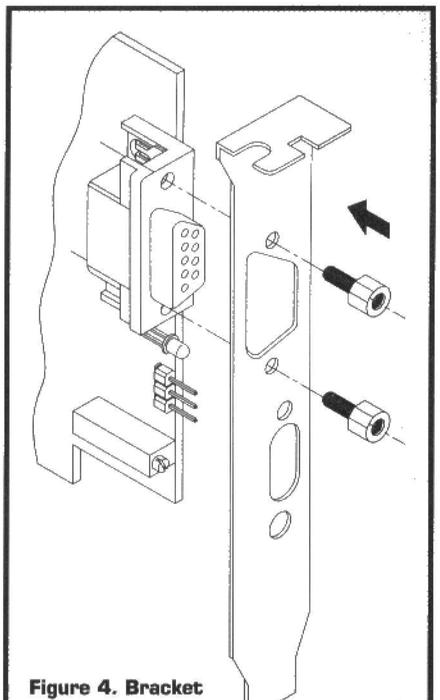
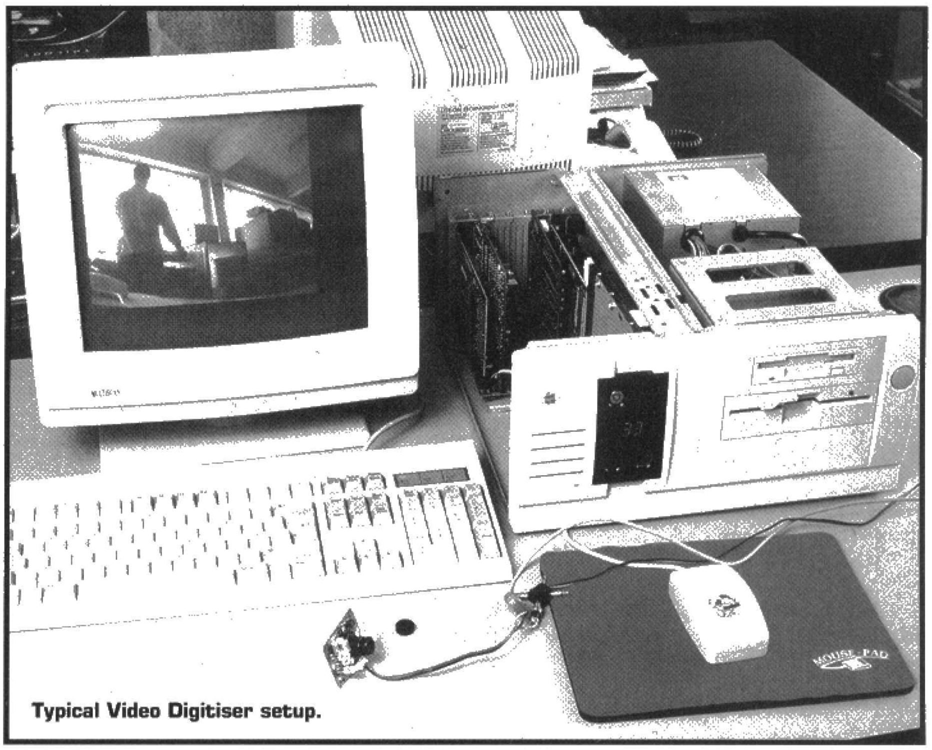


Figure 4. Bracket mounting details.



Typical Video Digitiser setup.

address counter (pin 11 of IC20 and pin 9 of IC21b) are used in colour mode, to select the input colour by the multiplexer, IC2.

I/O Address

The PC address bus interface is formed by IC6. To avoid conflict with other boards, the I/O address is configurable via selection jumpers J3 to J5.

Line Sync

To eliminate the double line sync pulses during the vertical sync period, the line sync pulses are fed via a monostable flip-flop (IC21a) to the phase-locked loop, IC12.

Phase-lock

The phase-locked frequency is generated by the 10MHz voltage-controlled crystal oscillator IC5f, and is divided to 15·625kHz by means of the dividers, IC8 to IC10. IC11 acts as a line counter, to prevent the digitising during the first 32 lines of the frame.

Basic Program Use

On starting up the program, by clicking on the 'K8100 VIDEO DIGITIZER' icon in Windows, a sub-menu of icons is displayed, of the various program options. If you require information, click on the 'Manual' icon, from which you may select instructions in either English, Dutch, German or French.

The screen manual provides details (additional to the booklet supplied) on general items, technical data, circuit diagram, PCB component side, assembly instructions, jumpers setting-up, connections to the system, adjustment and installation, a user manual, and Wingrab menu commands, plus a digitised colour picture of the card itself, captured by an example of a previously-built system. There are numerous other digitised images relating to the project to be found within the on-screen manual.

It is advisable to go through all of these various sections before building up the project. To run the software, it must first be installed onto your PC, from the disk provided in the kit. Enter the Windows™ 3.1 or higher operating environment, and from the file manager, with the supplied software disk placed in the appropriate drive on the machine, install the program by selecting the 'Run' command. Installation should be completed within a couple of minutes, depending on the type of computer being used – the program will confirm when it is ready for use.

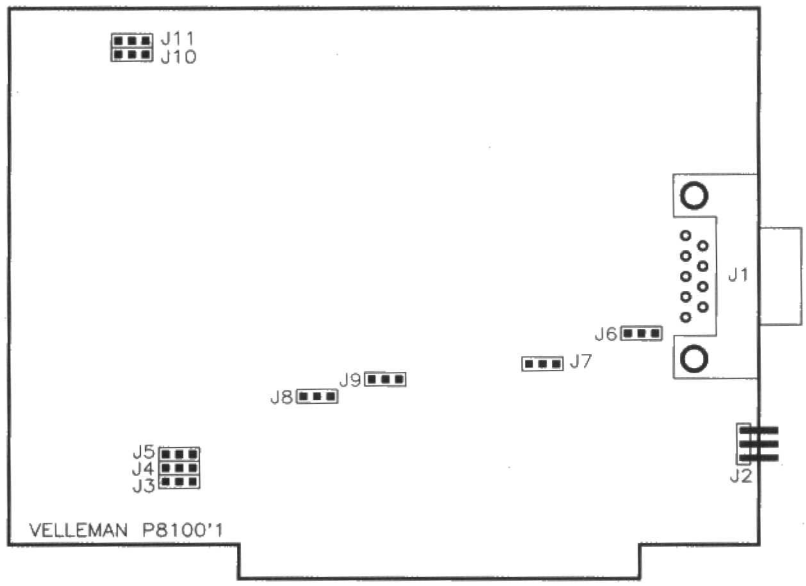


Figure 5a. Jumper positions.

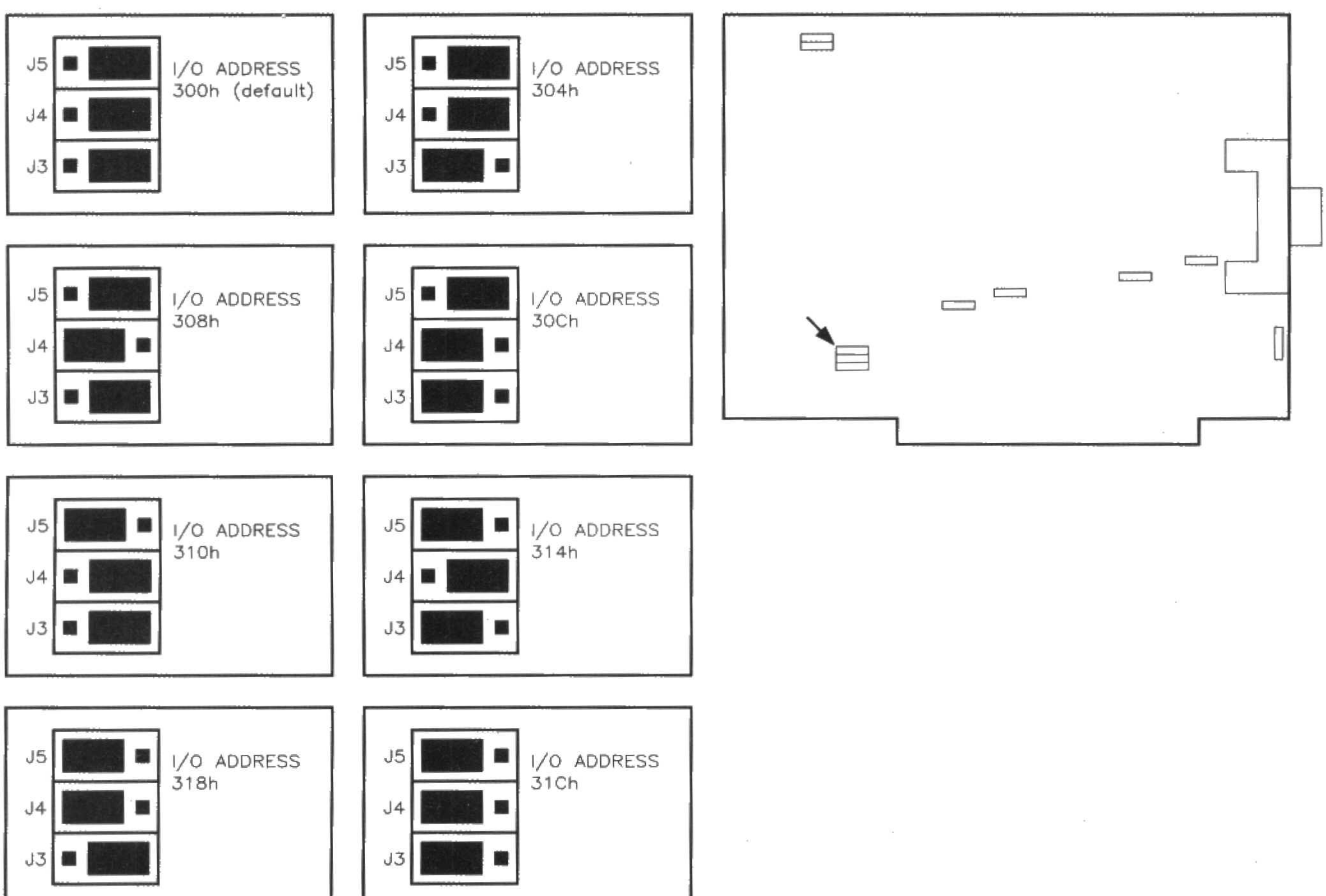


Figure 5b. I/O address jumper selection.

PCB Construction

A low-power (40W maximum), fine-tipped soldering iron should be used, along with fine solder, of no more than 1mm diameter. Assemble the PCB in order of ascending component size, smallest to largest, and ensure that all parts are fitted as close as possible to the board. Progress through from resistors, diodes, capacitors, RF chokes, LED (D4), transistor, trimmer capacitors and potentiometer, quartz crystal, the jumper connectors, IC sockets (observing correct orientation of the notches) and D-type socket. Ensure the correct polarity of the diodes, tantalum bead capacitors and LED. Note that there are two types of 24-pin DIL sockets used, one narrow (for IC6), and one wide (for IC13). The ICs should be plugged into their sockets last of all, observing anti-static precautions.

Having completed the assembly process, check your work carefully for solder whiskers, bridges and dry joints, and for misplaced components. Finally, clean excess flux off the board using a suitable solvent.

A suitable cable, (or cables) will have to be made up (or bought ready-made) to interconnect the video source with the 9-pin D-type socket on the digitiser card. Figures 3a to 3d provide details showing how the various options are wired up.

Testing and Adjustment

Fit the end plate bracket onto the finished PCB, as shown in Figure 4, then the various combinations of jumper positions will have to be set up to suit the type of input signal source, see Figures 5a to 5g. With the jumpers set correctly, place the assembly into a spare expansion slot in your PC, allowing sufficient space for access to the trimmer capacitors CV1 and CV2.

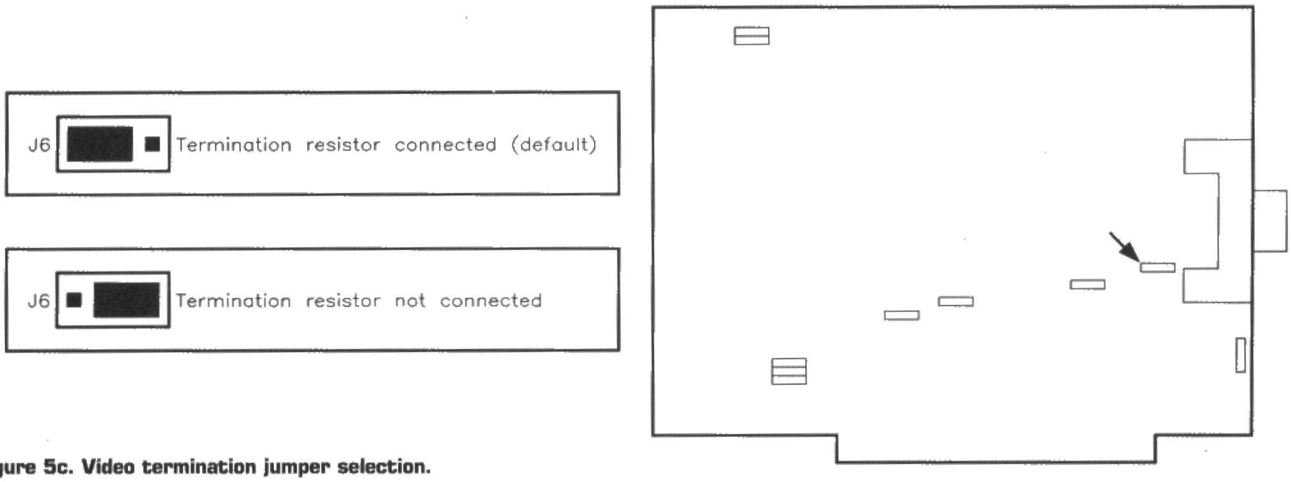


Figure 5c. Video termination jumper selection.

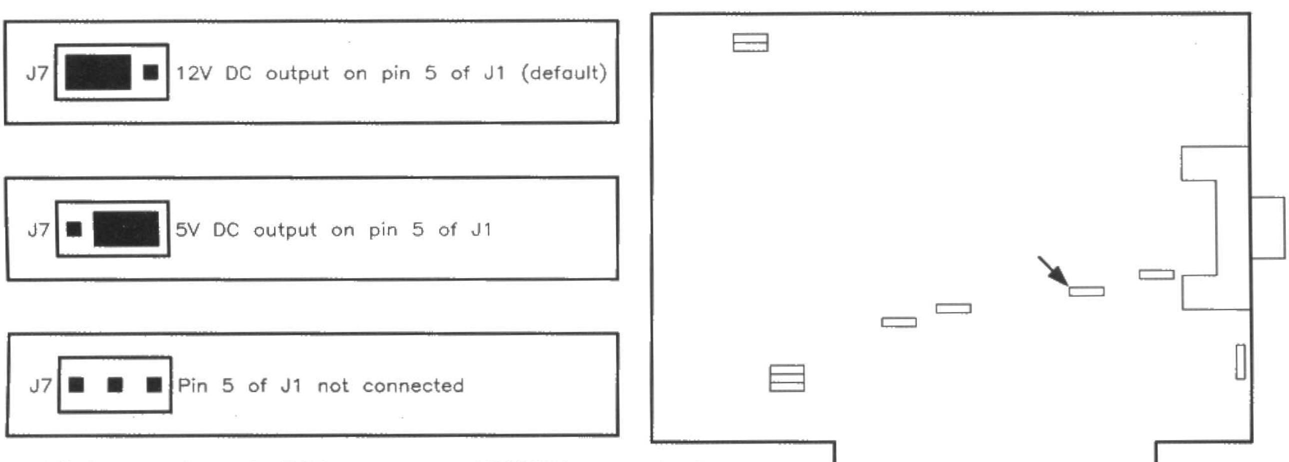


Figure 5d. Output voltages for RGB converter card K4600 jumper selection.

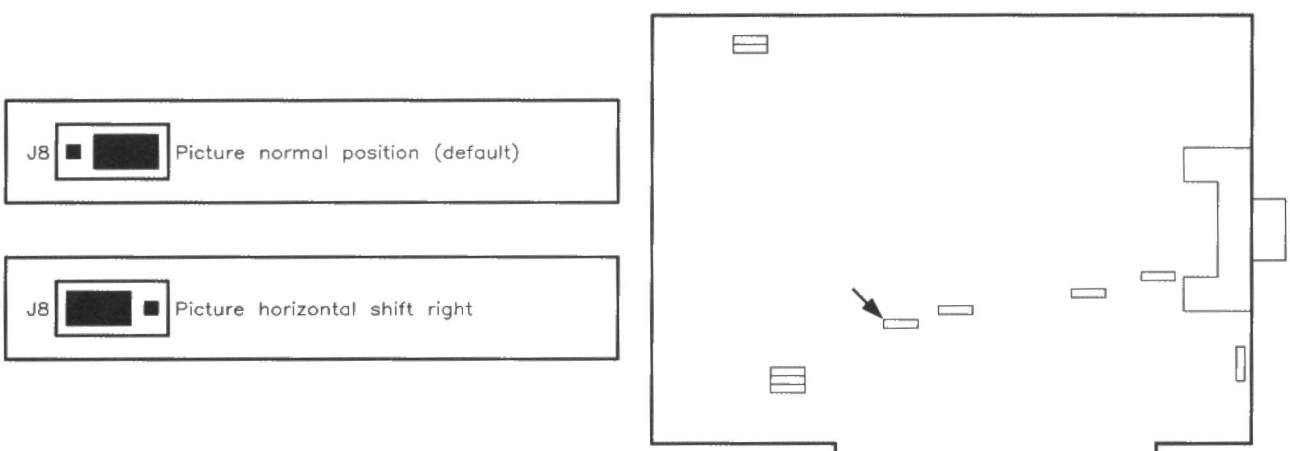


Figure 5e. Jumper positions for achieving horizontal shift of the picture.

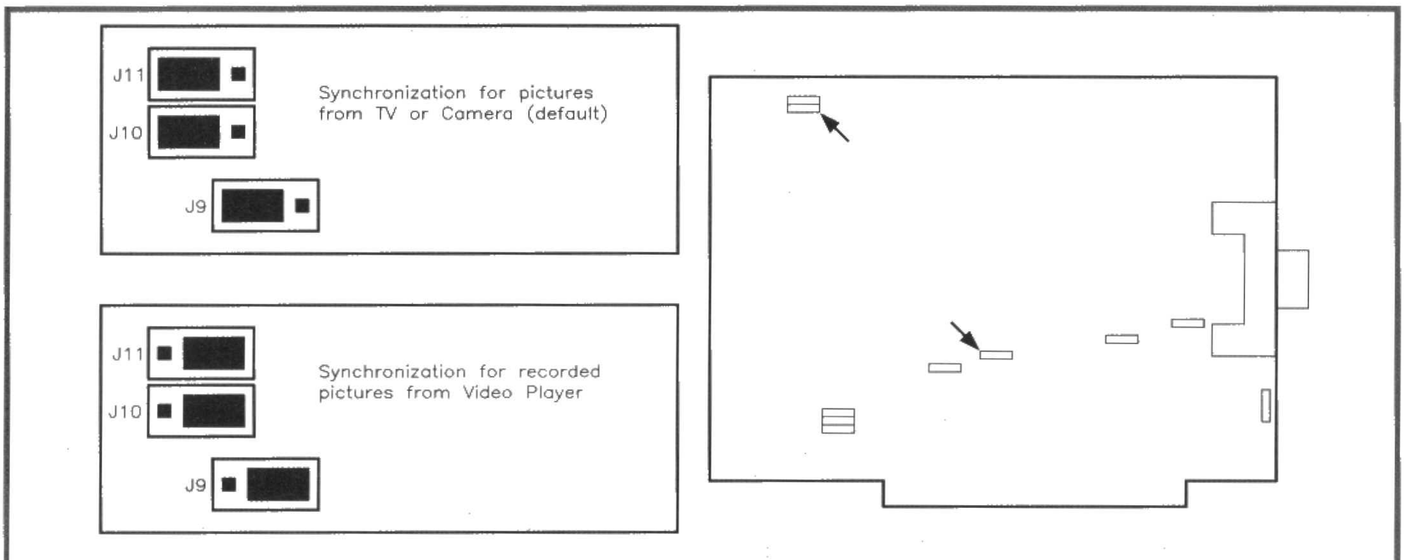


Figure 5f. Line synchronization jumper selection.

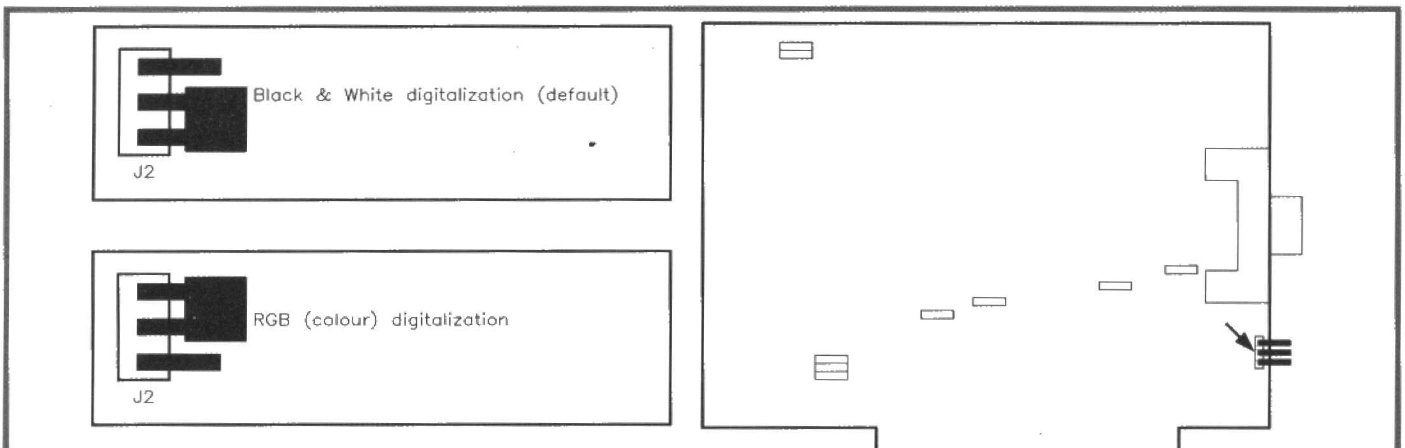


Figure 5g. Jumper positions for selection of input signal.

Use a securing screw on the end plate to secure the board. Start up the computer, and make sure that the PC fires up as usual, and that nothing starts getting suspiciously warm on the digitiser card; if there are any problems, switch off immediately, and recheck your assembly work. If all is well, proceed to set up the card variables as described.

Choosing the Correct Address

Start the program 'Address setup' in the K8100 program group, and from there, you can choose the selected address, appropriate to the jumper positions used. When using the Wingrab program, selection must be made with the 'Preferences' menu command.

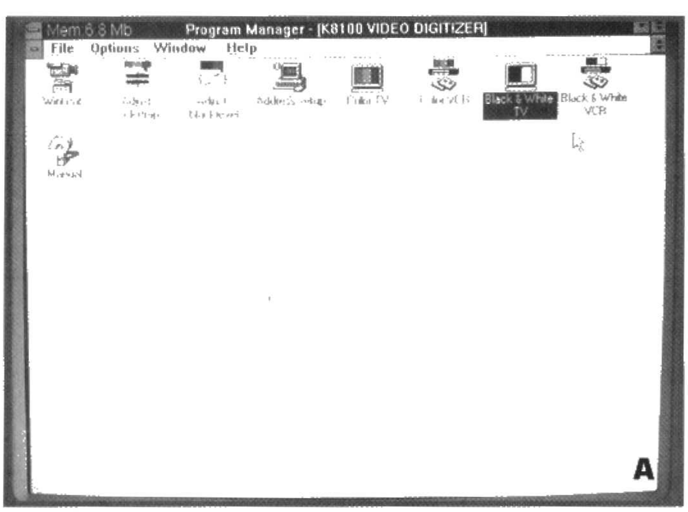
Synchronization Adjustment

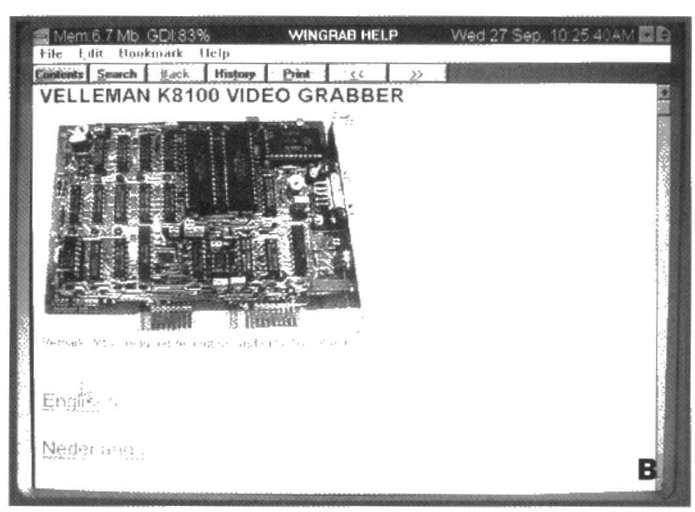
If you chose internal synchronization (jumpers J9-11=1), then the card must be adjusted to the incoming signal, as follows:

- Connect the card to a video source
- Turn on the composite video source
- Adjust trimmer capacitor CV1 until LED D4 lights constantly, indicating that the video signal is synchronized with the internal clock of the digitiser.

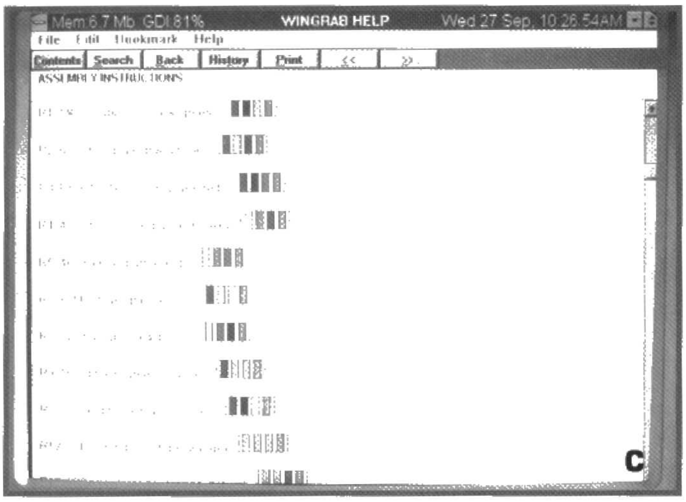
Adjusting the Colour Trap Filter

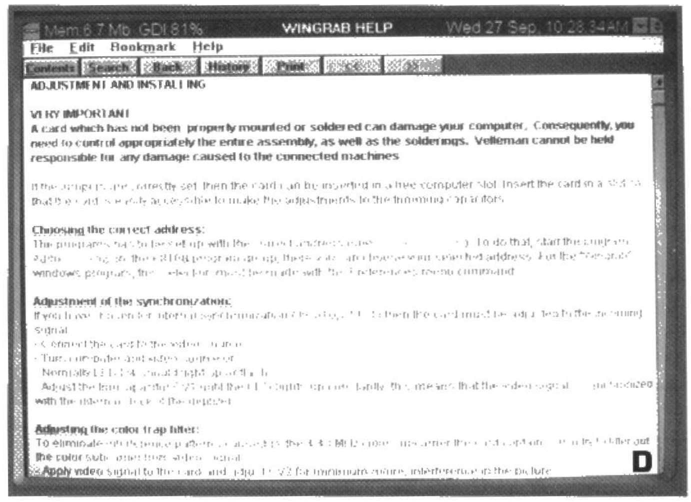
To eliminate interference patterns caused by the 4·43MHz colour subcarrier, the card contains circuitry to filter out the subcarrier from the video signal. To adjust the filter, proceed as follows:





Selection of screen shots from the supplied software: A. The icons. B. The main menu. C. Resistor colour-code display. D. User manual text.





- Apply a video signal to the card, and adjust trimmer CV2 for minimum moiré (picture interference)
- Alternatively, select the program option 'Adjust colortrap', and adjust the display number and pointer position to a minimum.

Black Level Adjustment

The black level of the picture is adjusted by altering RV1, whilst in the Wingrab option of the program, and with a video camera (with lens cap on) connected to the card via a suitable cable. Select the 'Adjust blacklevel' menu command, and set RV1 until a screen value of between 20 and 30 is obtained. Alternatively, click directly on the 'Adjust blacklevel' icon (i.e., without the Wingrab option being selected), and adjust the black level to the value stated on the screen.

Using the Video Digitiser

Having adjusted the parameters, the Video Digitiser card is ready for use. By clicking on the appropriate icon(s), and applying the required composite video input signal from a camera, VCR, etc., you should see the images appearing on the screen, confirming that digitisation is taking place. It is possible that you may need to adjust various other parameters to achieve a good picture, e.g., the camera focus, ambient lighting levels, etc. To save an image, select the appropriate icon, ie. 'Colour TV' and type 'S' (save), and enter **<filename>.tif**, e.g. **image.tif.**

VIDEO DIGITISER PARTS LIST

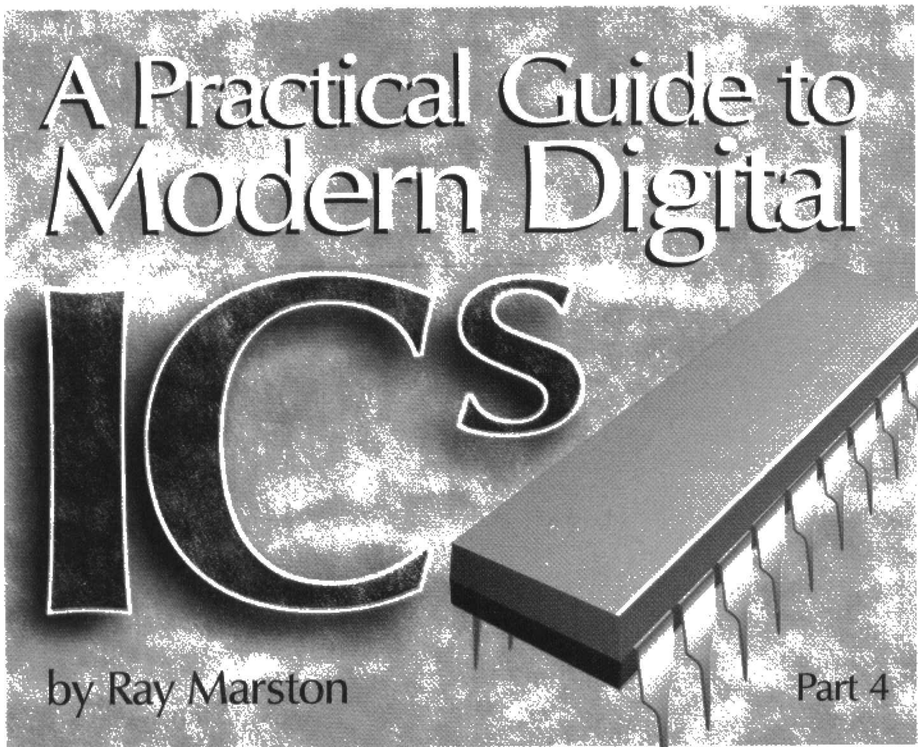
RESISTORS		
R1	1M	1
R2	680Ω	1
R3,6,11	1k	3
R4	470Ω	1
R5	4k7	1
R7	680k	1
R8	82Ω	1
R9	15k	1
R10	100k	1
R12	33k	1
R13	330Ω	1
R14	2k2	1
RV1	1k Multiturn Preset Potentiometer	1
CAPACITORS		
C1	10pF Ceramic Disc	1
C2	100pF Ceramic Disc	1
C3,10,11,13-18,24-34,36,39	100nF Resin-dipped Ceramic	22
C4	470pF Ceramic Disc	1
C5-7	4·7F 16V Tantalum Bead	3
C8,35	47pF Ceramic Disc	2
C9	22nF Ceramic Disc	1
C19,21	4n7F Ceramic Disc	2
C22	1µF 25V Tantalum Bead	1
C23	3n3F Ceramic Disc	1
CV1,2	22pF Trimmer	2
SEMICONDUCTORS		
D1,3,5,6	1N4148	4
D2	BB405B Varicap	1
D4	3mm Red LED	1
T1	2N2907	1
IC1	LM1881	1
IC2	74HC4052	1
IC3	74HC244	1
IC4	74HC00	1
IC5	74HC04	1
IC6	VK8100	1
IC7	74HC74	1
IC8	74HC162	1
IC9-11,16-20	74HC161	8
IC12	CD4046BE	1
IC13	TDA8703	1
IC14,15	621024 128K × 8-bit 70 to 100ns S-RAM	2
IC21	74HC112	1
MISCELLANEOUS		
L1	10µH RF Choke	1
L2,3	100µH RF Choke	2
X1	10MHz Crystal	1
J1	9-way Right-angled Sub-D-type Connector	1
J3-11	3-pin Straight Connector	9
J2	3-pin Right-angled Connector	1
	8-pin DIL Socket	1
	14-pin DIL Socket	3
	16-pin DIL Socket	12
	20-pin DIL Socket	1
	24-pin DIL Socket (Narrow spacing)	1
	24-pin DIL Socket (Wide spacing)	1
	32-pin DIL Socket	2
	End Plate Bracket	1
	Software Disk	1
	PCB	1
	Leaflet	1

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available in kit form only.

Order As 95010 (Video Digitiser) Price £139.99G1

Please Note: Some parts, which are specific to this project (e.g., PCB), are not available separately.



One of the most important events in the history of digital electronics was the development, in 1969, of the new IC technology known as CMOS. CMOS (Complementary Metal Oxide Semiconductor) digital IC elements have major advantages over TTL types. They are simple and inexpensive, consume near-zero quiescent current, have a very high input impedance, can operate over a wide range of supply voltages, have excellent noise immunity, and are very easy to use. In 1972, practical CMOS arrived on the commercial scene in the form of a brand-new medium-speed family of digital ICs known as the '4000-series'. This new family was not as fast as the TTL technology then in use in the rival '74-series' of digital ICs, but in the mid-1980s, a new high-speed type of CMOS was developed and introduced as a new member of the '74' family of devices. The advantages of this new 'fast' CMOS were so great, that in 1994, it overtook TTL in popularity within the '74-series', finally making CMOS the most popular of all modern digital IC technologies. This month the operating principles of the '4000' and '74-series' devices are explained, and also CMOS basic usage rules.

CMOS Basics

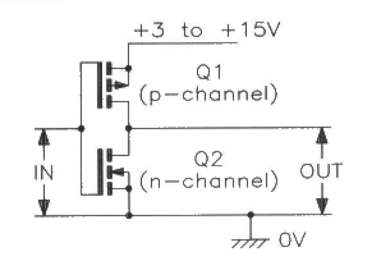
The most basic element in any digital IC family is the digital inverter. Figure 1 shows a basic CMOS inverter. It is a 'totem-pole' type of amplifier (see Part 1 of this series), and consists of a complementary pair of enhancement-mode MOSFETs wired in series between the two supply lines, with p-channel MOSFET, Q1, at the top, and n-channel MOSFET, Q2, below. The MOSFET gates (which have a near-infinite DC input impedance) are tied together at the input terminal, and the output is taken from the junction of the two devices. The pair can be powered from any supply in the 3 to 15V range. The basic digital action of the n-channel device is such that its drain-to-source path acts like an open-circuit switch when the input is at logic-0, or as a closed switch in series with a 400Ω resistor when the input is at logic-1. The p-channel MOSFET has the inverse of these characteristics, and acts like a closed switch plus a 400Ω resistance with a logic-0 input, and an open switch with a logic-1 input. The basic action of the CMOS inverter can be understood with the help of Figure 2.

Figure 2(a) shows the digital equivalent of the CMOS inverter circuit with a logic-0 input. Under this condition, Q1 (the p-channel MOSFET) acts like a closed switch in series with 400Ω, and Q2 acts like an open switch. The circuit thus draws zero quiescent current, but can 'source' fairly large drive currents into an external output-to-ground load via the 400Ω output resistance (R1) of the inverter. Figure 2(b) shows the inverter's equivalent circuit with a logic-1 input. In this case, Q1 acts like an open switch, but Q2 (the n-channel MOSFET) acts like a closed switch in series with 400Ω; the inverter thus draws zero quiescent current under this condition, but can 'sink' fairly large currents from an external supply-to-output load via its internal 400Ω output resistance (R2).

Thus, the basic CMOS digital inverter can be used with any supply in the 3 to 15V range, has a near-infinite input impedance, draws near-zero supply current (typically 0·01μA) with a logic-0 or logic-1 input, can source or sink substantial output currents, and has an output impedance of about 400Ω. Note that, unlike the TTL inverter, its output can swing all the way from zero to the full positive supply rail value, since no potentials are lost via saturation or forward-biased junction voltages, etc. Typically, a basic (mid-1970s style) CMOS stage has a propagation delay ranging from 12ns when using a 12V supply, to 60ns at 3V.

The '4000A-series' of ICs

The initial 1972 range of digital ICs was known as the '4000A-series'. It used the basic type of



IN	Q1	Q2	OUT
0	ON	OFF	1
1	OFF	ON	0

Figure 1. Circuit and Truth Table of a basic CMOS inverter.

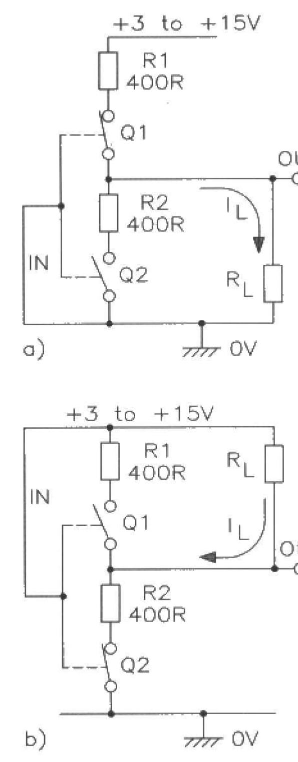


Figure 2. Equivalent circuits of the CMOS digital inverter with (a) logic-0 and (b) logic-1 inputs.

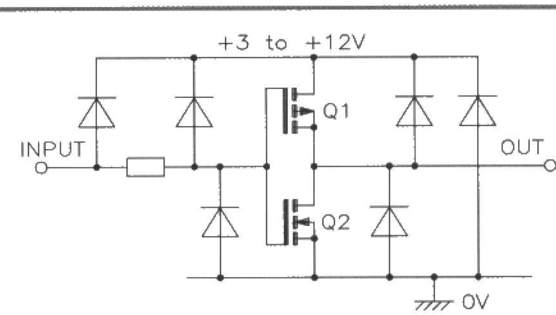


Figure 3. Basic '4000A-series' inverter stage, with internal input and output protection networks.

CMOS inverter shown in Figure 1, but incorporated extensive diode-resistor 'clamping' networks to protect its MOSFETs against damage from static charges, etc. Thus, a complete 'A'-series inverter stage took the basic form shown in Figure 3.

Commercial testing of the early 'A'-series range of CMOS devices quickly revealed a number of design problems. Their on-off resistance values were, for example, very sensitive to gamma radiation effects, thus limiting their value in outer-space projects, and they gave uneven 'high' and 'low' output impedances and propagation delays, etc., i.e. they had poor output symmetry. However, the most important problem was that their output switching levels were overly-sensitive to the magnitudes of their input switching signals; the root cause of this problem can be understood with the aid of Figure 4, which shows the linear characteristics of the CMOS inverter's two MOSFETs when they are operated from a 15V supply.

Note in Figure 4, that each MOSFET acts like a voltage-controlled resistance. The n-channel device has a near-infinite drain-to-source resistance at zero input voltage: the resistance remains high until the input rises to a 'threshold' value of about 1·5 to 2V, but then decreases as the input voltage is increased, eventually falling to about 400Ω when the input equals the supply line voltage.

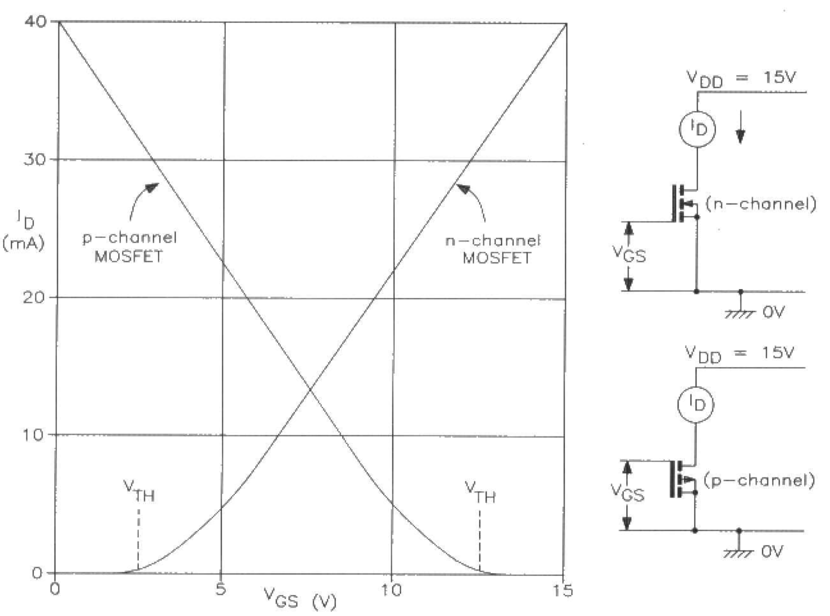


Figure 4. Typical gate volts/drain-current characteristics of p- and n-channel MOSFETs operated from a 15V supply.

The p-channel MOSFET has the reverse of these characteristics. Thus, when the two MOSFETs are wired in series and used as a 15V basic CMOS inverter, they produce the typical drain-current transfer graph shown in Figure 5, and the voltage transfer graph of Figure 6; these graphs can be explained as follows:

Suppose in Figures 5 and 6, that the CMOS inverter's input voltage is slowly increased upwards from zero. The inverter current is near-zero until the input exceeds the n-channel MOSFET's threshold voltage, at which point, its resistance starts to fall and that of the p-channel MOSFET starts to increase. Under this condition, the inverter current is dictated by the larger of the two resistances; when the input is far less than half-supply volts, the n-channel MOSFET resistance is far greater than that of the p-channel device, so the output is high (at logic-1). When the input is at a transition value somewhere between 30 and 70% of the supply voltage, the two MOSFETs have similar resistance values and the inverter acts as a linear amplifier, with a voltage gain of about 30dB, and draws several mA of supply current. Under this condition, small changes of input voltage cause large changes of output voltage. When the input is further increased, well above half-supply volts, the resistance of the n-channel MOSFET falls below that of the p-channel device, and the output goes low (to logic-0). Finally, when the input rises above the threshold value of the p-channel MOSFET, it acts like an open switch, and the inverter current again falls to near-zero.

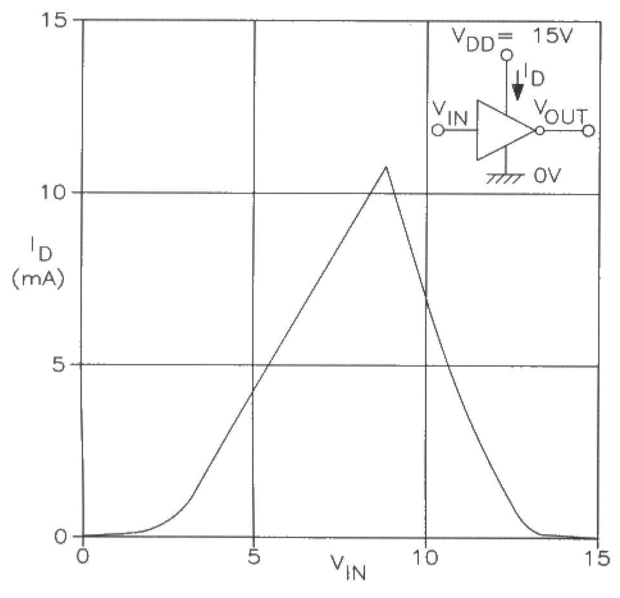


Figure 5. Typical drain-current transfer characteristics of the simple CMOS inverter.

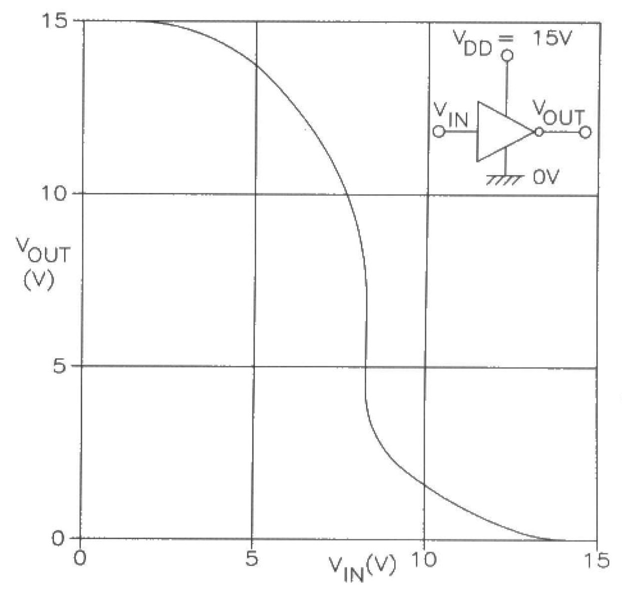


Figure 6. Typical voltage transfer characteristics of the simple CMOS inverter.

Thus, the 'A' series type of inverter gives an output that switches fully between the supply rail values only if its input voltage swings well above and below its two internal 'threshold' voltage values. Note (from Figure 5) that CMOS draws a brief pulse of supply current each time it goes through a switching transition; the more often CMOS changes state in a given time, the greater are the number of current pulses that it takes from the supply, and the greater is its mean current consumption. Thus, CMOS current consumption is directly proportional to switching frequency.

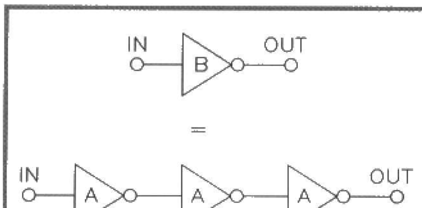


Figure 7. A 'B-series' CMOS inverter can be made by wiring three 'A-series' types in series.

The '4000B-series' of ICs

The defects of the '4000A-series' were so severe, that an improved CMOS series, known as the '4000B' or 'buffered' series, was introduced in about 1975, and the old '4000A-series' was slowly phased out of production. The major feature of this new series is that each of its 'inverters' consists of three basic inverters wired in series, as shown in Figure 7, so that each 'buffered' inverter has a typical linear voltage gain of 70 to 90dB and has the typical voltage transfer graph of Figure 8, in which any input below $V_{DD}/3$ is recognised as a logic-0 input, and any input above $2V_{DD}/3$ is recognised as a logic-1 input. Other changes in the new series, include greatly improved output-drive symmetry and immunity to gamma-radiation effects, new and better input and output protection networks (see Figure 9), and improved voltage ratings (to 15V maximum in most manufacturer's versions, compared to 12V maximum in the original 'A-series').

One disadvantage of the 'B-series' is that its propagation delays are larger than those of the old 'A-series'. To counter this problem, a few new-generation devices are produced in an 'unbuffered' format (denoted by a 'UB' suffix), but incorporate all the other improvements of the 'B-series'. Typically, 'UB' inverters have an AC gain of 23dB at 10V, and are useful in several analogue applications (see next month's part of this series). Note that the bandwidth and propagation delays of a CMOS device vary with supply voltage and with capacitive output loading; Table 1 lists the typical propagation delays of both 'UB' and 'B-series' inverters when used with supply values of 5V, 10V, and 15V, when driving a 50pF load.

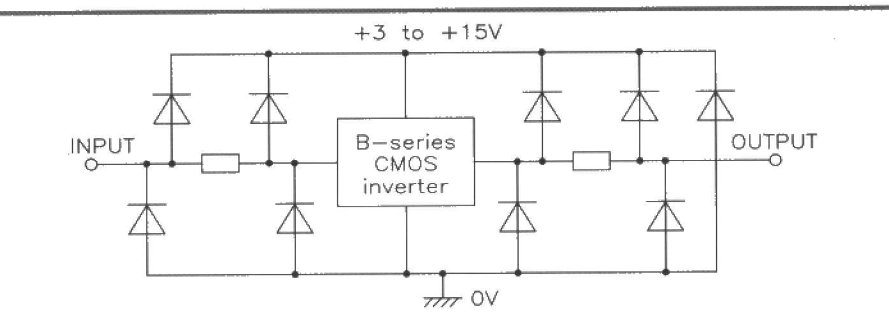
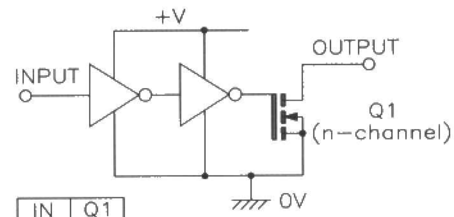


Figure 9. Basic '4000B-series' inverter, with typical input and output protection networks.



IN	Q1
0	OFF
1	ON

Figure 10. Basic CMOS inverter with open-drain (o.d.) output.

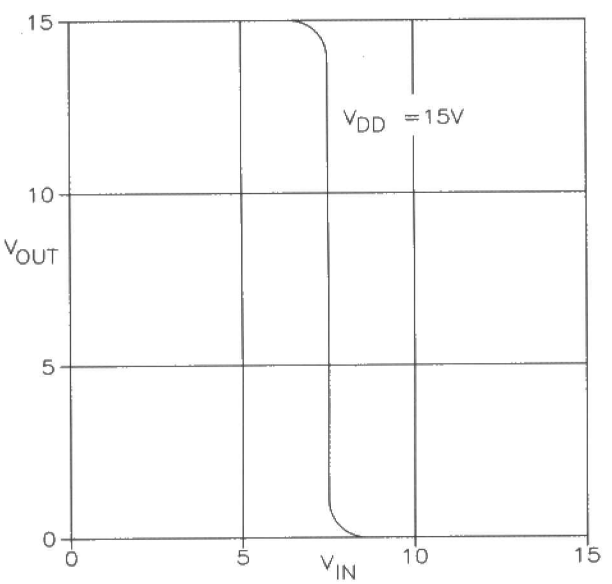
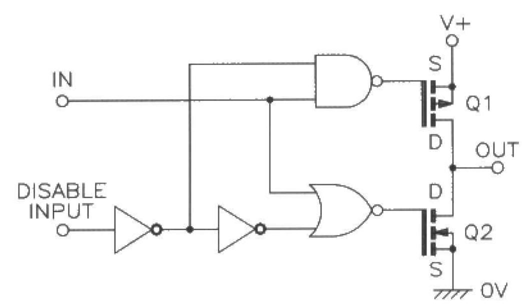


Figure 8. Voltage transfer graph of the 'B-series' inverter shown in Figure 7.



IN	Disable Input	Q1	Q2	OUT
0	0	OFF	ON	0
1	0	ON	OFF	1
Don't Care	1	OFF	OFF	Open Circuit

Figure 11. Basic circuit of a 3-state CMOS non-inverting buffer.

The '4500B-series' of ICs

The '4000B-series' range of ICs consists mainly of fairly simple SSI or MSI devices, such as logic gates and simple counters, etc. In the late 1970s and early 1980s, a number of more complex MSI and LSI 'B' type CMOS ICs such as encoders, decoders, and presettable counters, etc., were introduced; these advanced devices carry '45XX' or '47XX' numbers, and are generally known as the '4500-series' of CMOS ICs.

'Fast' CMOS ICs

In the early 1980s, engineers strove to design a really fast type of CMOS that could outclass 'LS' TTL when operated from a 5V supply,

V_{DD} (V)	Typical Propagation Delays (ns)	
	'UB-series'	'B-series'
5	40	120
10	25	50
15	20	35

Table 1. Typical propagation delays of '4000B-series' inverters when driving a 50pF load.

and could thus become the dominant technology within the '74-series' of ICs. Normal CMOS is based on MOSFET (Metal-Oxide Silicon FET) technology, and this is simply a variation of IGFET (Insulated-Gate FET) technology. Specifically, a MOSFET device is an IGFET device that uses Metal-Oxide gate insulation, and the first big step in developing 'fast' CMOS was to use Silicon-Oxide rather than Metal-Oxide gate insulation in the basic IGFETs. This simple measure resulted in a dramatic reduction in the IGFET's internal input capacitance, and an equally dramatic increase in operating speed. The next step was to apply these new IGFETs to the basic CMOS configuration, and when this was done and significant changes were made in the element's geometry, the resulting device acted like normal CMOS but was as fast as 'LS' TTL when operated from a 5V supply, and (unlike some other versions of CMOS) had excellent output drive capability. Strictly, this new device should have been given a special name,

such as CSOS (Complementary Silicon-Oxide Silicon FET), but instead, was simply christened 'fast' CMOS.

'Fast' CMOS has many similarities with conventional '4000B-series' CMOS. It is available in both buffered (triple-inverter) and unbuffered (single inverter) basic versions, and has all inputs and outputs protected via internal diode-resistor networks. It can (in most cases) use any supply in the 2 to 6V range, and when first introduced, was intended to replace many existing devices in the '74' series of ICs. Since then, however, it has also been used to make 'fast' versions of many popular devices within the '4000B' and '4500B-series' of ICs.

CMOS '74-series' Sub-families

When the '74-series' of IC first appeared in 1972, it was based entirely on TTL technology, which inherently consumes a fairly high quiescent current. In the late 1970s, a slightly modified version of standard CMOS (optimised for 5V operation) was introduced as a new 'C' sub-family within the '74-series' range of devices, and offered the advantage of near-zero quiescent current consumption. This 'C' sub-family was too slow and had too weak an output-drive capability to obtain great popularity, but in later years, the 'fast' type of CMOS was developed specifically for use in the '74-series', as already described, and so far, a total of five CMOS sub-families have been introduced in the '74-series', as follows:

Standard (C) CMOS (now obsolete). This was virtually normal MOSFET-type CMOS, in a '74-series' format. Typically, a single 74C00 2-input NAND gate consumed about 15mW at 10MHz, and had a propagation delay of 60ns at 5V.

High-speed (HC) CMOS. Introduced in the early 1980s, this is the basic 'fast' silicon-oxide version of CMOS, and gives speed performances similar to LS TTL, but with CMOS levels of power consumption. HC '74-series' devices using this technology have CMOS-compatible inputs; typically, a single 74HC00 2-input NAND gate consumes less than 1μA of quiescent current, and has a propagation delay of 8ns at 5V.

High-speed (HCT) CMOS. These are fast HC-type devices, but have TTL-compatible inputs and are meant to be driven directly from TTL outputs. Typically, a 74HCT00 2-input NAND gate consumes less than 1μA of quiescent current and has a propagation delay of 18ns.

Advanced High-speed (AC) CMOS. In the late 1980s, further advances in high-speed CMOS design and fabrication techniques yielded even-better speed performances. AC '74-series' devices using this technology have CMOS-compatible inputs; typically, a 74AC00 2-input NAND gate has a propagation delay of 5ns.

Advanced High-speed (ACT) CMOS. These are AC-type devices, but have TTL-compatible inputs and are meant to be driven from TTL outputs. Typically, a 74ACT00 2-input NAND gate has a propagation delay of 7ns.

Basic CMOS Circuit Variations

There are three important variations of the basic CMOS circuit that are often used in ICs in the medium-speed '4000B-series' and fast '74-series' ranges of devices. The first of these is the 'open drain' configuration, which is used in some inverters and buffers, etc. Figure 10 shows a typical open-drain inverter, which is configured like a normal high-gain 3-stage CMOS inverter, except that the final stage consists of a single n-channel enhancement-mode IGFET (Q1) that has its drain connected directly to the circuit's output terminal. The circuit's action is such that Q1 is cut off when the input is at logic-0, and is driven on when the input is at logic-1. The circuit can be used to directly drive an external load that is connected between 'OUTPUT' and the +ve supply rail, in which case, the load activates when a logic-1 input is applied.

The second variation concerns the use of a 'Tri-State' or '3-state' type of output, that in normal use, gives a conventional logic-0 or logic-1 low-impedance output, but can also be set to a third state, in which the output is effectively open-circuit. This facility is useful in allowing several outputs or inputs to be wired to a common bus, and to communicate along that bus by ENABLING only one output and one input device at a time. Figure 11 shows the typical circuit of a non-inverting buffer of this type, together with its Truth Table. Thus, when the DISABLE INPUT control is at logic-0, the circuit gives normal 'buffer' operation; under this condition, Q1 is driven OFF and Q2 is driven ON when IN is at logic-0, thus driving OUT to logic-0; the reverse of this action is obtained when the input is at logic-1. When the DISABLE INPUT control is set to logic-1, both Q1 and Q2 are driven OFF, irrespective of the state of the IN input, and under this condition, OUT is effectively disabled, and acts as an open circuit. Figure 12 shows the simplified equivalent circuit of this buffer when it is in its high-impedance output state.

The third CMOS circuit variation is that of the 'bilateral switch' or transmission gate. The basic action of any enhancement-mode IGFET is such that its drain-to-source path acts like a near-perfect unidirectional switch; when the IGFET is OFF, the path acts like an open circuit, and when it is ON, it acts like a low-value resistor and (unlike a bipolar transistor) does not suffer from saturation-voltage problems, etc. When turned on, an n-channel IGFET passes current from drain-to-source, and a p-channel IGFET passes current from source-to-drain. Thus, a near-perfect bidirectional or 'bilateral' electronic switch can be made by wiring an n-channel and a p-channel IGFET in parallel (source-to-source and drain-to-drain) and driving their gates in antiphase, as shown in Figure 13. Here, both IGFET paths are effectively open when the CONTROL

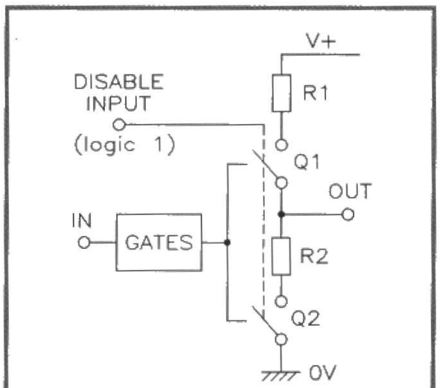


Figure 12. Equivalent of a 3-state buffer circuit in its 'third', high-impedance state.

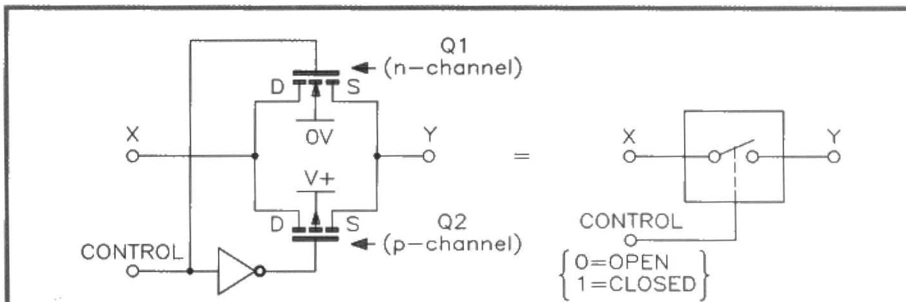


Figure 13. Basic CMOS bilateral switch or 'transmission gate'.

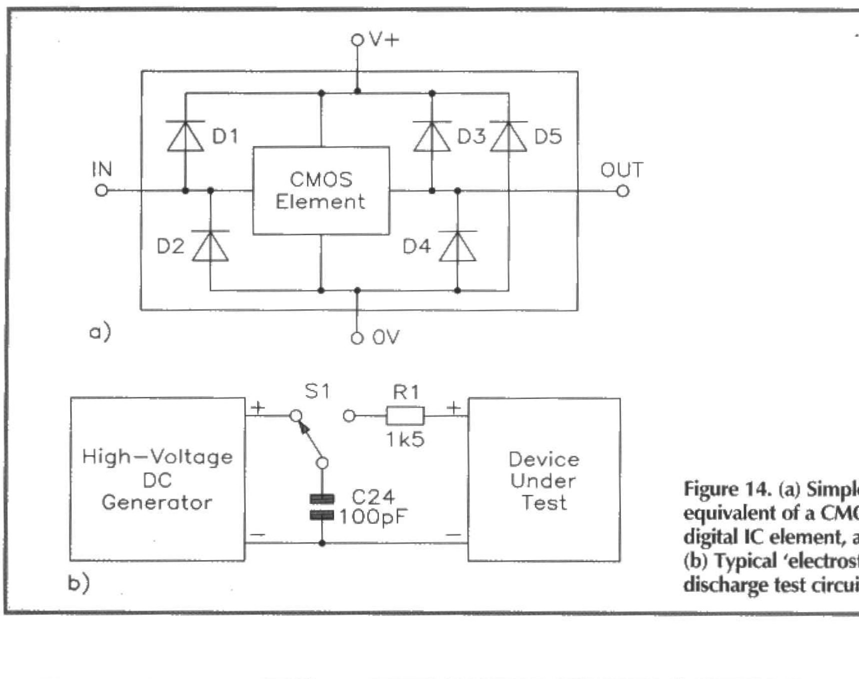


Figure 14. (a) Simple equivalent of a CMOS digital IC element, and (b) Typical 'electrostatic discharge test circuit'.

input is at logic-0, and closed when the CONTROL input is at logic-1. Under the 'closed' condition, current can flow from X to Y via Q1, or from Y to X via Q2; current can thus flow in either direction between these points, and the circuit thus simulates a simple electro-mechanical switch.

CMOS Basic Usage Rules

CMOS ICs are very easy to use. They are very tolerant of supply voltage variations, and unlike TTL types, present very few input-drive/output-drive matching problems. There are, in fact, only seven 'basic usage' themes to consider when dealing with CMOS, and these will now be dealt with below.

Type Selection

The question "which CMOS family should I use?" can easily be answered with the help of Table 1, which lists the major characteristics of the six readily-available modern CMOS sub-families and compares them with those of LS TTL. Of these types, the 4000UB sub-family is only available in the form of a few simple buffer and inverter ICs, and should be regarded as a simple variant of the main 4000B sub-family, and the 74HCT and 74ACT types are meant to be directly driven from TTL outputs, and are of use only in a few specialised applications.

Of the remaining three CMOS sub-families (4000B, 74HC, and 74AC), the 4000B sub-family can be used in any application that requires the use of a supply in the range 3 to 15V and in which maximum operating frequencies do not exceed 2MHz at 5V, or 6MHz at 15V. Alternatively, if supply voltages are restricted to the 2 to 6V range, the 74HC sub-family can be used to operate at frequencies up to 40MHz at 5V, or the 74AC sub-family at frequencies up to 100MHz at 5V.

Note that all TTL ICs have special input-drive requirements, and the 'Fan-out' numbers in Table 2 show how many parallel-connected standard LS TTL inputs can be directly driven from the output of each listed sub-family member. Thus, 4000B CMOS can only drive one such input, but 74HC and HCT CMOS can each drive 10 such inputs, and 74AC and ACT can each drive up to 60 LS TTL inputs.

Handling CMOS

CMOS is based on high-impedance IGFET technology, which (when being handled) is easily damaged by high-voltage static charges of the type that can build up on the body of the person handling them. All CMOS digital ICs incorporate extensive internal diode-clamping circuitry that is designed to protect them against damage from 'reasonable' values of static discharge when the IC is being handled. Figure 14(a) shows the basic form of this internal protection circuitry; here, D1 or D2 conduct if IN tries to go above V+ or below 0V, D3 or D4 conduct if OUT tries to go above V+ or below 0V, and D5 conducts if 0V tries to go above V+; D5 also conducts in the Zener mode if V+ goes more than about 20V above 0V.

Figure 14(b) shows the basic laboratory circuit that is used to simulate 'reasonable' values of static charge from a human body when testing CMOS ICs; C1 has a value of 100pF and simulates the typical body capacitance of a charged human adult, and R1 has a value of 1k5 and simulates the body's typical discharge resistance. When a CMOS element is being given evaluation tests, C1 is charged to a high-value test voltage via S1, and is then applied to two of the IC's test points via S1 and R1. A 4-pin element of the type shown in Figure 14(a) has a total of twelve possible 2-pin test permutations, and the test circuit is applied to each of these 2-pin permutations during the full test sequence. Typically, CMOS digital ICs are expected to survive a test voltage of 2·5kV in all of these test modes.

It is important to understand the meaning of these tests. Suppose that a 3kV test voltage is applied between the IC's reverse-connected 0V and V+ pins. Under this condition, D5 is forward biased, and C1 discharges via D5 and R1; R1 limits C1's peak discharge current to 2A and gives it a basic time constant of 150ns. Thus, D5 passes only a very brief spike of forward current as C1 discharges; if D1's thermal time constant is very long compared to the period of the spike, it may not suffer damage from this test, even though it can only handle normal DC currents of (say) 25mA maximum. Note that the peak voltage appearing across D5 in this test is roughly 1V, most of C1's 3kV discharge voltage being lost across R1.

The protection networks used in CMOS ICs are not designed to be effective against massive values of static discharge, such as the several thousand volts that may be generated by a person vigorously prancing about on a nylon carpet, etc. Consequently, when handling 'naked' CMOS ICs, always take sensible precautions against the build-up of large static charges; do not wear nylon clothing or use nylon mats/carpets in the workshop, and make sure that soldering irons, etc., are correctly grounded. To be really safe, wear a grounded metal wrist strap when working with CMOS, particularly when soldering. Note, however, that in reality, it is very unlikely that you will ever damage a CMOS IC in normal handling, even if you don't bother to wear a grounded wrist strap.

	LS TTL	4000B CMOS	4000UB CMOS	74HC CMOS	74HCT CMOS	74AC CMOS	74ACT CMOS
Supply Voltage Range	4·75 to 5·25V	3 to 15V	3 to 15V	2 to 6V	4·5 to 5·5V	2 to 6V	4·5 to 5·25V
Quiescent Current (per gate)	0·5mA	0·01μA	0·01μA	0·02μA	0·02μA	0·02μA	0·02μA
Propagation Delay (per gate)	9ns	125ns@5V 50ns@10V 40ns@15V	90ns@5V 50ns@10V 40ns@15V	8ns@5V	10ns@5V	5ns@5V	7ns@5V
Maximum Operating Frequency	40MHz @5V	2MHz@5V 5MHz@10V 6MHz@15V	–	40MHz @5V	–	100MHz @5V	–
Fan-out @5V, to LS TTL Inputs	20	1	1	10	10	60	60

Table 2. General characteristics of LS TTL and the six major CMOS digital IC types.

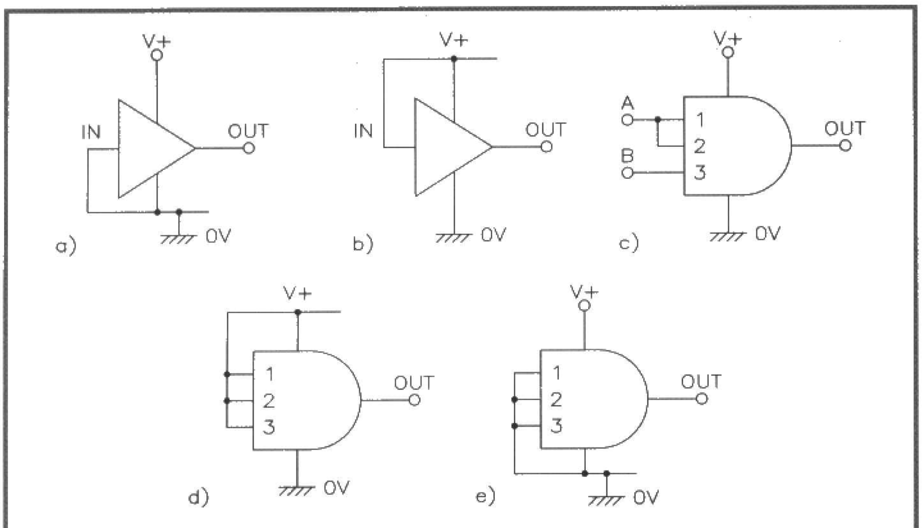


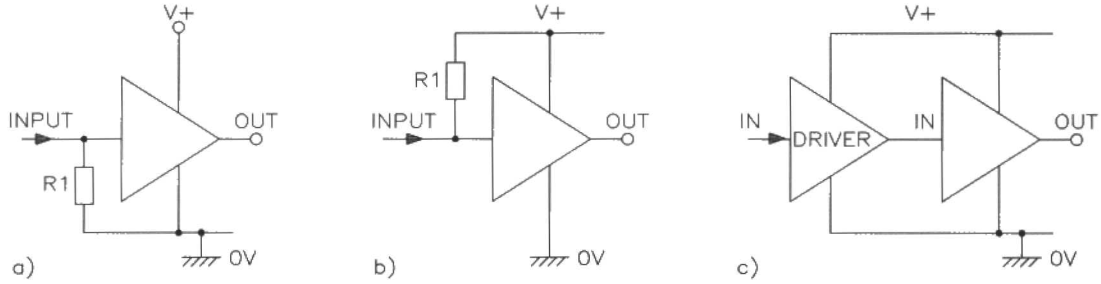
Figure 15. Alternative ways of connecting unwanted CMOS inputs (see text).

Power Supplies

CMOS ICs of the 4000B and 74HC and 74AC types are designed to operate over a wide range of supply voltages, and can thus be powered from batteries or from regulated or unregulated power supplies. 74HCT and 74ACT types, however, are designed to operate from supplies in the 4·5 to 5·5V range, and must be powered from low-impedance well-regulated supplies.

All CMOS ICs generate fast pulse-switching edges. Consequently, most CMOS circuits should be used with a PCB that is designed to give excellent high-frequency supply decoupling to each IC. In general, the PCB's supply and ground-rail tracks must be as wide as

Figure 16. All 'used' CMOS inputs must be tied to definite logic levels (see text).



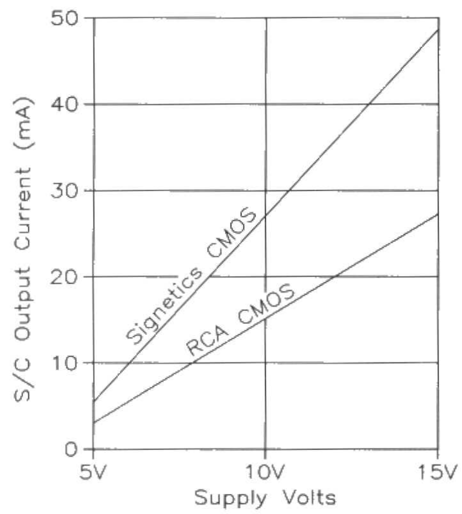


Figure 17. Typical '4000B-series' short-circuit output currents (at 25°C).

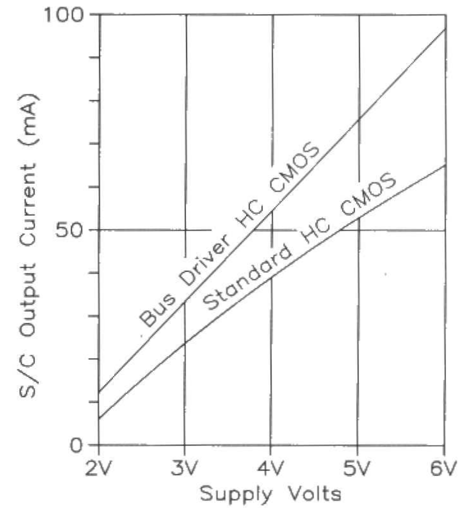


Figure 18. Typical '74HC-series' short-circuit output currents (at 25°C).

possible (ideally, the '0V' track should take the form of a ground plane), all connections and inter-connections should be as short and direct as possible, the PCB's supply rails should be liberally sprinkled with $4\mu7$F Tantalum electrolytic capacitors (at least one per 10 ICs) to enhance LF decoupling, and with 10nF disc ceramics (at least one per 4 ICs, fitted as close as possible between an IC's supply pins) to enhance HF decoupling.

When experimenting with CMOS ICs, always take great care to ensure that the power supply can never be connected in the wrong polarity, since this will cause heavy supply currents to flow through the IC's protective diode networks (specifically, through D5 in Figure 14(a) and cause instant damage to the IC's substrate.

Input Signals

When using CMOS, all IC input signals must (unless the IC is fitted with a Schmitt-type input) have very sharp rising and falling edges. If rise or fall times are too long, they may allow the input terminal to hover in the CMOS element's linear zone long enough for the element to burst into wild oscillations and generate spasmodic output signals that may disrupt associated circuitry (such as counters and registers, etc). If necessary, 'slow' input signals can be converted into 'fast' ones by feeding them to the IC's input terminal via CMOS Schmitt elements.

One possible way of damaging CMOS is via a very low impedance input or output 'signal' that is either connected to the CMOS when its power supply is switched off, or is of such large amplitude that it forces the input terminal well above the positive supply line or below the zero-volts rail. In either case, a heavy current will flow through one or more of the IC's protection diodes (specifically, through input diodes D1 or D2, or output diodes D3 or D4 in Figure 14(a), and the substrate may be damaged. The possibility of such damage can be eliminated by wiring a 1kΩ resistor in series with each input/output terminal, so that any current that does flow is limited to a safe value of a few mA.

Unused Inputs

Unused CMOS input terminals must never be allowed to simply 'float', but must always be tied to definite logic levels by either connecting them directly to the supply or ground rails (depending on the IC's logic requirements), or to some other point with well-defined logic levels. Figure 15 shows some of the available options. If the unwanted input is on a multi-input gate, it can be disabled by shorting it to one of the gate's used inputs, as in Figure 15(c), where a 3-input AND gate is shown used as a 2-input type. If the IC is a multiple gate type in which an entire gate is unwanted, the gate should be disabled by tying all of its inputs to a common high or low point, as in Figures 15(d) and 15(e).

All 'used' CMOS input terminals must also be tied to definite logic levels, and must never be allowed to 'float'. Figure 16 shows three commonly-used options that may be used. In Figure 16(a), the input is normally tied low by R1, and in Figure 16(b) it is normally tied high by R1. In Figure 16(c), the input is direct-coupled to the output of a driving stage, which determines the input logic level.

Output Signals

CMOS totem-pole output stages are designed to source or sink fairly high peak values of output current. Consequently, if the output is shorted directly to the IC's zero-volts or positive supply rail, the resulting DC output currents can in some cases be so high that the IC may be damaged. Thus, when a CMOS IC is used to drive a DC load, its load current must always be limited to a safe value. Figure 17 shows the typical short-circuit output currents of two different manufacturer's '4000B-series' CMOS output stages over the 5 to 15V operating voltage range; in practice, the maximum DC values of these output loads must be limited to 10mA of current or 100mW of power dissipation, whichever is the lower of these values.

Continued on page 61.

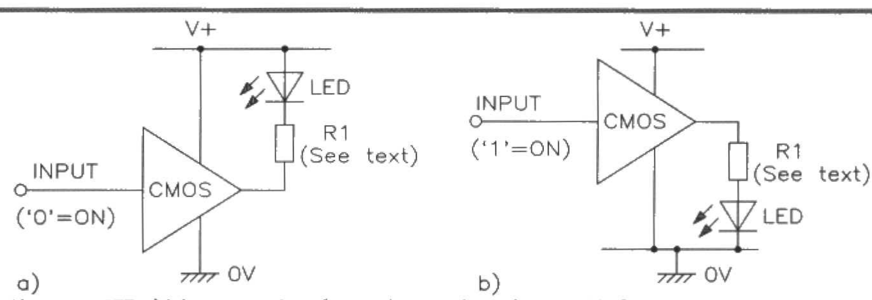


Figure 19. LED-driving output interface, using non-inverting CMOS elements.

NEWS Report

'M' Allow More Space

Applications for a full Amateur Radio Licence will receive a new 'M' call sign from the beginning of April next year. Full licensees are currently issued with a 'G' call sign, while novices, who will be unaffected by this change, are issued with call signs commencing with a '2'. According to the Radio Communications Agency, the 'G' series is close to exhaustion, and the change needs to made to accommodate new registrations.

Contact: Radio Communications Agency Amateur Radio Unit, Tel: (0171) 215 2171.

Radio Amateur of the Year

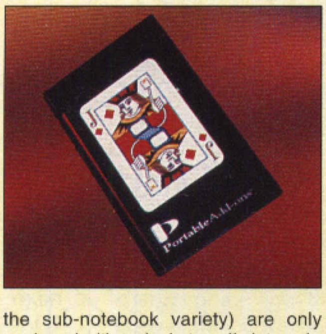
Leroy Kirby picked up a cheque for £300 from the Radio Communications Agency at the RSGB International HF Convention in Windsor, last month. He also received a Sony general coverage receiver from the RGSB and a number of other prizes. 16-year old Leroy from Cardigan, Dyfed is actively involved with his local amateur radio emergency service, and has managed to reactivate his local YMCA amateur radio club which he helps to run as vice-chairman. His main interest is packet radio, and he has helped establish a local Bulletin Board System.

Contact: RGSB, Tel: (01707) 659015.

Two Card Trick

In what is claimed to be a UK first, Portable Add-ons has launched the Trumpcard. Occupying a single Type II PC Card slot, the Trumpcard combines two popular functions – a high-performance 16-bit Ethernet card and a fast v.34 fax/modem. Both sections are functionally independent, and either or both can be used at any one time. Simultaneous modem and Ethernet operation is now possible, permitting information to be transferred between a LAN and a remote site.

For a growing number of portable users, there are never enough PC Card slots. Different applications require different cards, and swapping may be needed. Some machines (particularly the sub-notebook variety) are only equipped with a single type II slot, making Trumpcard an ideal device.



Contact: Portable Add-ons, Tel: (01483) 452304.

Daewoo Installs Silicon Graphics Supercomputer

Daewoo Motor has installed a Silicon Graphics Power Challenge XL supercomputer at its Technical Centre in Worthing, Sussex. Engineers are using the new supercomputer in the Engineering Analysis Group, to support Daewoo's advanced predictive engineering techniques. These allow engineers to assess the effects of a crash before physical models of cars are used in tests.

Daewoo claims that by creating a sophisticated computer model of the car and its components, the effects of an impact can be studied.

Contact: Silicon Graphics, Tel: (01734) 257500.

Memory Doubler

Everyone needs more memory. With the release of an increasing number of memory-hogging applications, not to mention Windows '95, it is no longer good enough to have a mere 4M-bytes. At least, that was until Roderick Manhattan Group launched SoftRAM. This novel software package takes hold of the PC at the physical addressing level, and using a memory compression technique, that effectively doubles memory capacity. In addition, the package reallocates the physical RAM and optimises memory in terms of both space and speed. SoftRAM costs £69, and requires a 386 or higher PC, Windows '95 or 3.x, and 4M-bytes of memory.

Contact: Roderick Manhattan Group, Tel: (0181) 875 4400.

Interactive Game Play from BT

Computer games have received a fourth dimension, with the announcement from BT that they are to launch a computer games network which will allow players to compete with each other over the telephone network. Called Wireplay, the system will be piloted in January next year, with a full nationwide launch scheduled for the second half of 1996.

Wireplay will allow customers with compatible games on their PC to access the system via modem. Once logged on, the customer will enter the Wireplay open forum and be able to challenge and play other players, or even join a league and play in teams. The system is designed to work with PCs with a capacity of a 386 or above, and with modems with a speed of 9,600bit/s and above.

BT is currently working with games publishers and associations, including Acclaim, Activision, Argonaut, Electronic Arts, Gremlin Interactive, Interplay, Microprose, Myelin, SC, Virgin Interactive Entertainment, and the English Bridge Union.

Contact: BT, Tel: (0171) 356 5369.

Racal-Datacom Helps Autoglass

Autoglass, a national automotive glass replacement company in the UK, has installed a corporate network, implemented by Racal-Datacom, to run a complete range of business applications. The network links the head office in Bedford, distribution centre in Leicester, and branch offices from Inverness to Truro. It gives some 800 users fast, easy access to the information necessary to offer the best service possible, including customer orders, stock control, automatic stock replenishment, installation details and billing with direct links to insurance companies.

Contact: Racal-Datacom, Tel: (01734) 669969.

Windows '95 Red Herring

"All the hype about Windows '95 is detracting from the key issue in the operating systems market. All eyes should really be on Microsoft's Windows NT Server. The increasing power of Windows NT Server is making the workgroup server market the most strongly contested segment of the European operating system market", said Heather Clark, author of Operating Systems: Markets and Futures, a new report from Ovum.

Ovum claims that between now and the year 2000, Windows NT Server will be the fastest-growing server operating system in the European operating systems market. Ovum forecasts a growth rate of 52% for Windows NT Server, to reach over 1 million units in Europe by the year 2000.

Contact: Ovum, Tel: (0171) 255 2670.

FIFO Memory Gives 5V Performance at 3·3V Power

A low-power 3·3V family of First In First Out (FIFO) memories from Texas Instruments (TI) allows high-performance workstations and desktop multimedia systems to consume less power, yet maintain the performance of their 5V counterparts. Unlike some 3·3V devices, which are scaled back or re-characterised 5V CMOS FIFOs to run at 3·3V, TI has put additional effort into redesigning 5V FIFOs to give optimum performance at 3·3V.

Simply scaling back or recharacterising a FIFO is easier than developing a new design, however, recharacterised devices often achieve 40% less performance in terms of operating frequencies, propagation delays and drive capability.

Contact: Texas Instruments, Tel: (01403) 211048.

Digital Printing

Sony printers have gone digital, with the launch of a digital colour dye sublimation A4 printer, which gives near-photographic quality colour prints. A newly developed thermal head, with a resolution of 300 dots per inch, gives an effective pixel area of 2,550 by 3,508, with over 16 million colour variations per pixel. With appropriate software options, the printer can provide both bit-map and Postscript printing, ensuring compatibility with Macintosh, Windows and Sun environments.

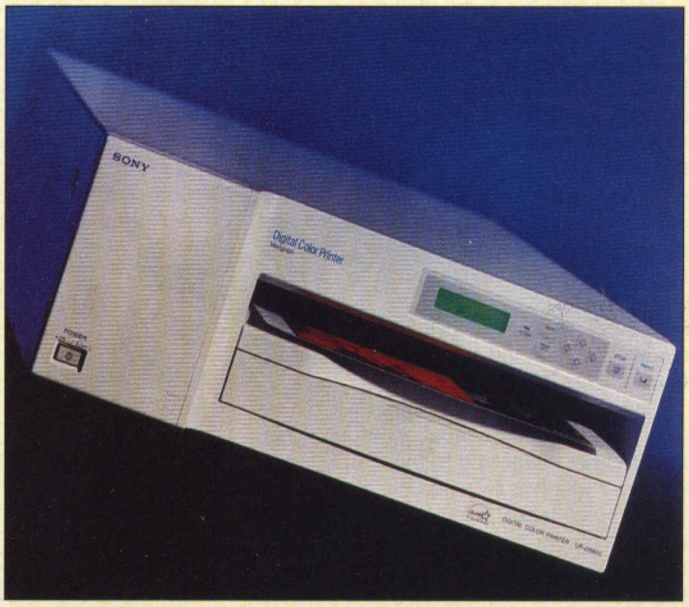
Contact: Sony, Tel: (01932) 816000.

Intel P6 to Power Trillion-Operations Per Second

The United States Department of Energy (DOE) has selected Intel's new microprocessor, which will deliver more than ten times the performance of today's fastest supercomputers. More than 6,000 of Intel's next-generation P6 microprocessor will power the new system, to be located at the Sandia National Laboratories.

The computer will be used primarily for computer simulation, and will be the first in the world to achieve the goal of calculating more than a trillion operations per second. "President Clinton is committed to ending all underground nuclear testing, and computer simulation will be a principal means for ensuring the safety, reliability and effectiveness of the US nuclear deterrent. We are embarking on a ten-year program to advance the state of high-performance computing to meet national security objectives", said Victor Reis, assistant secretary for energy programmes at DOE.

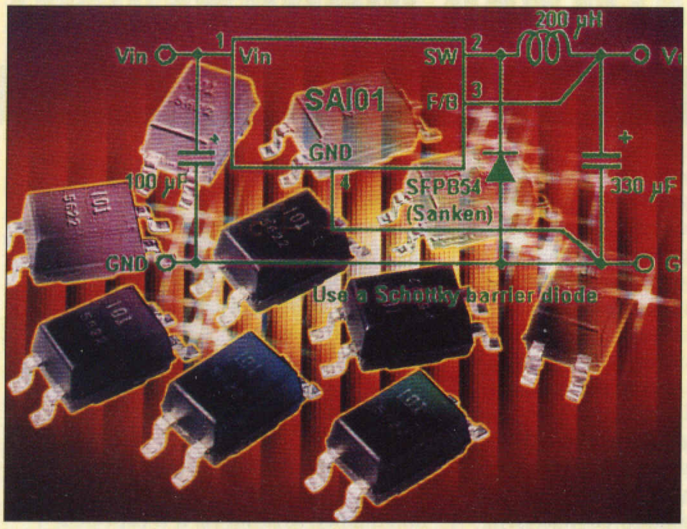
Contact: Intel, Tel: (01793) 403000.



IC Eases Power-Supply Design

A surface-mount power regulator integrated circuit from Allegro Microsystems enables switch-mode power supplies to be designed using only four external components. The SAI01 provides an output current of 0·5A at 5V from an input voltage range of 7 to 33V, with typical line regulation of 80mV. The device has an efficiency of 80%, with typical power dissipation of 0·75W. The switching regulator uses a built-in reference oscillator with a frequency of 60kHz, with phase correction and output voltage adjusted internally. Over-current and over-temperature protection are built-in.

Contact: Allegro MicroSystems, Tel: (01932) 253355.



Wafer Fab Pilots on Teesside

Pilot production has started at the Samsung Electronics industrial complex at Wynyard Park, Teesside. Samsung Electronics will eventually manufacture one million devices a year at the new plant, once all production lines have reached full capacity. The new 200 acre industrial complex will be completed by the year 2000.

Contact: Samsung Electronics, Tel: (0181) 391 0333.

Recovery Service for Victims of Chip Theft

Theft of computer components is one of the fastest-growing and most lucrative forms of crime in the UK today. Every week, hundreds of offices up and down the country are broken into, and PCs stripped of their high-value components – usually easily-removable processors and memory chips (SIMMs), which are now more valuable weight-for-weight than diamonds. Such thefts usually leave computer equipment relatively undamaged, but unusable.

Organisations hit by component theft will often go several days without access to computer-based information and applications, while they wait for their PC dealer or manufacturer to supply replacement parts. The effect on day-to-day business can be devastating. Now, Response Computer Maintenance has launched a new service to help organisations recover more rapidly from the theft of computer components. Response's new pcRECOVERY service provides on-site engineers to replace standard memory SIMMs and Intel processors within one working day of call-out, anywhere on the UK mainland.

Victims of component theft do not need to have taken out a maintenance contract with Response to benefit from the pcRECOVERY service – it is available to anyone calling the company's information hotline. All eight of Response's UK branches have pcRECOVERY engineers on call. The company makes a fixed charge for the cost of parts and labour, and if PCs cannot be made to work simply by replacing their components, Response's workshop service can repair most makes of machine within a few days.

Contact: Response Computer Maintenance, Tel: (0345) 686686.

Young European Scientists of 1995

Five exceptional students from the United Kingdom, Germany and Ireland, beat over 80 top-notch finalists for the title of the 7th European Union Young Scientist. The Europe-wide final has been held in the UK for the first time, hosted by the British Association for the Advancement of Science (BAAS). Ian Taylor, minister for science and technology, awarded prizes to Christopher Mead and Matthew Taylor (UK), Sven Siegle (Germany), Brian Fitzpatrick and Shane Markey (Ireland), at the British Association Festival of Science, held in Newcastle at the beginning of September.

Contact: European Community, Tel: (0171) 215 5000.

Millions Wasted on Printing in Corporate UK

A recent report has revealed that running page printers cost corporate UK over £294million in 1994 and is anticipated to reach £393million by the end of 1995. The independent report, entitled 'European Page Printer Market 1994 to 1999', was carried out by BIS Strategic Decisions. In calculating the total cost of toner, the photoconductor or drum and cartridge case, all items that have to be regularly replaced during most printers' lifetimes, the report was able to reveal that running page printers is resulting in corporates unnecessarily wasting millions of pounds.

The £294million figure does not even include the cost of purchasing printers, but is simply the baseline costs of running them. The report finds that the reason running costs are escalating significantly, is that with most low-end (0 to 25 page per minute) printers, such as those from Hewlett-Packard, Lexmark and Canon, every time the toner runs out, the whole 'all-in-one cartridges' have to be replaced at considerable cost. In the UK, in 1994 alone, 2·6 million cartridges were replaced and 700,000 were recycled, costing British business £19·5million. In addition to this, toner and photo conductors for printers which do not use all-in-one cartridges must be included, which adds another £95·5million to the total, bringing it to £294million.

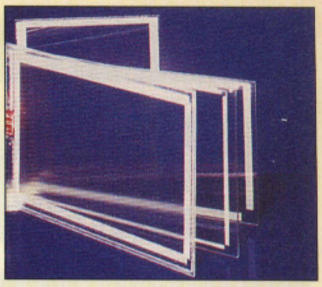
Contact: BIS Strategic Decisions, Tel: (01582) 405678.

PCB Service for Hobbyists

Thanks to a growing number of low-cost PCB software packages, any PC user can now design high-quality PCBs. However, the cost of equipment to produce one-off PCB designs remains prohibitively expensive for the hobbyist wanting to produce the occasional design.

Fledgling PCB manufacturer, Etch-Tech Boards, is looking to plug this gap in the market, with a new service for the hobbyist. Its hobbyist service offers single- and double-sided conventional PCBs at a cost of 12p/cm^2 single-sided and 18p/cm^2 double-sided. The largest board size available through this service is 15 × 25cm. For an information pack, write to Etch-Tech Boards, PO Box 1566, Salisbury, Wiltshire SP1 3XX.

Resistive Touch Screens



Lucas has launched a range of resistive touch screens for prototype development. Available in six sizes to fit most LCDs, the touch screens provide greater light transmission over comparative touch screen systems.

Contact: Lucas, Tel: (01535) 661144.

Tolling Trials

EasyToll, comprising RAM Mobile Data, Centre-file and Green Flag, has been selected by the Department of Transport as one of the eight consortia to take part in a research programme to test motorway tolling technology. The EasyToll solution is based on the ROBIN (Road Billing Net) system. It uses the Global Positioning System and the RAM Network to meet the Department's requirements for a system which will be both environmentally friendly and not disrupt traffic flow on the UK's busy motorways. Contact: RAM Mobile Data, Tel: (0181) 990 9090.

ARM Builds Embedded RISC Momentum

Cambridge-based Advanced RISC Machines Limited (ARM) has added NEC to its growing list of global semiconductor partners. The NEC partnership is part of an on-going 'open business model' strategy, that has helped ARM to evolve its semiconductor licensees to include ten of the world's leading semiconductor manufacturers. Each partner licensee uses the same base ARM technology, but differentiates its offerings with value added technology, applications, product, market, design and customer focus, so that the breadth of ARM applications is second-to-none.

"This overwhelming show of support for the ARM architecture is unheralded. Now, more than ever, embedded designers have the tools they need to quickly develop applications that require a small, high-performance, low-power, low-cost, 32-bit RISC processor. The addition of NEC further assists ARM with becoming the standard to dominate the embedded RISC market place", said Robin Saxby, ARM president and CEO.

Contact: Advanced RISC Machines, Tel: (01223) 400400.

Divides in British Society Reinforced by IT

Information Technology (IT) is reinforcing the divides in British society, rather than breaking them down, as was initially expected when the IT revolution began, according to a MORI report conducted on behalf of Motorola. The report goes on to state that familiarity with, and positive attitudes towards IT are noticeably higher in those groups that enjoyed advantaged status before the IT revolution began, including men, Southerners, younger age groups, the employed, higher socioeconomic groups, and the better educated.

Contact: Motorola, Tel: (01753) 575555.

Personal Single-chip Audio Processing

The new TDA1548T audio processor from Philips Semiconductors incorporates Bitstream filters for digital de-emphasis, volume and tone control, together with high-performance Bitstream DACs and headphone amplifiers. The device provides a single-chip solution to all the sound functions required in CD and DCC stereo players. The device is compatible with I^2S or LSB-justified format serial data, and outputs a 1·7V Pk-to-Pk audio signal into 32.

Contact: Philips Semiconductors, Tel: (+31) 40 72 20 91.

A TECHNICAL LOOK AT NETWORK MANAGEMENT

by Frank Booty

ONE of the most emotive topics in the networking area today, is the subject of network management, not least, because of the difficulties of defining what network management means. For many, management conjures up everything from the ability to control the infrastructure equipment itself, through to the provision of detailed data decoding and analysis, and physical cable management. Add to this, the dimension of local area network (LAN), wide area network (WAN) and telecommunications technologies, and the issue becomes complex and open to misinterpretation.

This article will attempt to provide an overview of network management definitions, protocols and products, and give guidance to help the user define what is required for his network and business needs from a network management system. Key questions will be provided to assist in specifying and choosing a network management platform.

There is an unquestionable need for network management. Gone are the days of simple, single vendor networks, where management was straightforward and proprietary. Today, the norm is for large corporate networks to span national and international boundaries, and to typically comprise a wealth of different vendors' equipment. Management systems are required to be more efficient, enabling the manager to be proactive rather than reactive (few organisations can afford to dedicate a large team to the day-to-day running of their network). Simultaneously, a network failure has a greater impact on users who have come to rely on high levels of serviceability.

The future is no less contentious, with the role of network management becoming ever more demanding. The market researcher, Datapro, recently estimated that the spending on management between the beginning of 1994 and end of 1995 is likely to double, with the UK accounting for over 30% of the total (the largest percentage of the European market).

So, the article will look at network management today, considering the market in terms of the key players and the key products on offer. There is also a focus on the primary management environments, and a look ahead to some of the trends likely to emerge.

Today's Management Arena

Within the LAN environment, it is the Simple Network Management Protocol (SNMP) that continues to dominate the available products. Its foothold stems from the acceptance of TCP/IP (Transmission Control Protocol/Internet Protocol) as a *de facto* standard. As the name states, the S in SNMP stands for 'simple', reflecting the ease of implementation which has contributed to its widespread take-up by management vendors. It is this simplicity however, that now threatens its downfall.

SNMP's four base commands (GET, GET NEXT, SET and TRAP) are seen as both inadequate and inefficient, primarily because they do not address the increasingly important area of data security and because of the unnecessary loading of network bandwidth caused by centralised polling for individual requests for information. The result has been a number of developments involving enhancements to SNMP and hybrid SNMP/OSI protocols.

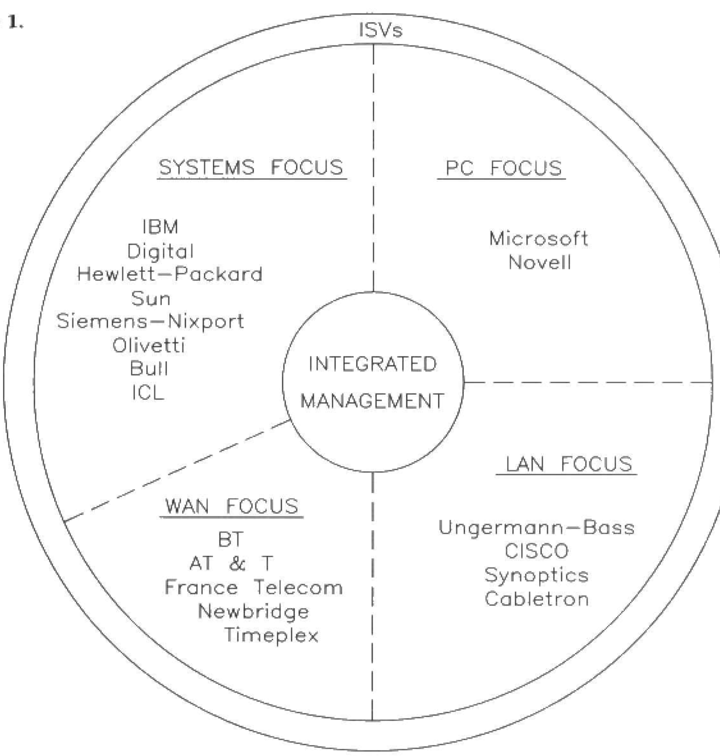
Firstly, SNMP II, which was developed by the Internet Engineering Task Force (IETF). This deals with the area of security and incorporates encryption standards – hence SNMP II is also referred to as Secure SNMP. Additionally, it incorporates a bulk retrieval command which as implied, enables polling for information in volume and ensures maximum efficiency of bandwidth usage.

Simultaneously with the conception of SNMP II, four of the original developers of SNMP were working on further enhancements to the SNMP protocol. The Simple Management Protocol (SMP) builds on SNMP II, and encompasses application management, peer-to-peer management and systems management, in addition to network management.

SNMP II has been widely demonstrated, and is now being implemented. Although there is still a certain amount of confusion, the situation is beginning to clear. The efforts of the Working Groups for SNMP Version II and SMP have been combined and defined as SNMPv2. It is expected within the industry that SNMPv2 will ultimately supersede SNMP although there will be a time lag. This is because the two are incompatible (isn't the computer and networking industry wonderful), and will require upgrades to be undertaken by both management and infrastructure vendors.

Co-existence is possible in one of two ways: through a Proxy Manager, whereby a remote device acting as a gateway translates between SNMP and SNMPv2 or vice-versa; or users could implement a bilingual Network Management Station. This means that the central management platform supports both SNMP and SNMPv2, and will

Figure 1.



ISVs = Independent Software Vendors, a group concerned with selling software products to bring additional network management and application management functions and tools to the management frameworks listed.

use the correct protocol stack depending on what device is being managed.

Further management protocol developments have concentrated on using the OSI Common Management Information Protocol (CMIP) over both a TCP/IP and LLC (Logical Link Control, OSI data link layer protocols defined for LANs) transport mechanism. Known as CMO and CMOL respectively, neither of these has yet been implemented to any significant degree, although a small increase is expected up to the end of 1995.

Management in the WAN environment has not reflected the same trends as that of the younger LAN counterpart, and has traditionally been dominated by proprietary systems supplied by specific equipment vendors. Although proprietary systems still proliferate, WAN suppliers are increasingly looking to incorporate SNMP agents or develop proxy management stations which enable integration with central management systems. This does not, however, include the router market, where the majority of suppliers have implemented SNMP.

The network management marketplace can be viewed from the two perspectives of key players and key products:

Key Players

Key players in the market can be further categorised into three groups. The first group comprises those vendors who have a management system really just to complement an existing product range. These systems will typically be home-grown, such as those from Retix or Newbridge, while others may be sold on an OEM basis as a base platform on which to build further applications. These suppliers include Chipcom and Cisco, who have adopted SunNet Manager (more on this later). Also, the existing equipment vendor systems will typically utilise SNMP, although they tend to be element managers which only provide full management of their own products with limited support for third party products.

The second category are those suppliers who are independent, having no existing networking of their own and therefore, no axe to grind with any particular supplier. Examples here, include companies such as Network Managers Ltd. and Lexcel (formerly Micro Technology).

The third group covers the corporates who already have well-defined communications architectures which cover network management. Specifically, this includes IBM (SNA), Digital (EMA), BT and AT&T. Here, management products tend to be heavily oriented to their proprietary users, with a standards-based interface (SNMP or in some cases CMIP) into the outside world, see Figure 1.

Key Products

This category is subdivided into two groups: The first group are specific management products, either PC or workstation based, which include systems such as Spectrum from Cabletron and Network Managers NMC applications. Essentially, these are packages which although customisable, can be supplied (as far as management can be) off the shelf.

This is distinct from the second group, which are management environments. These are what can be regarded as development platforms or toolkits, which are either sold on an OEM basis to equipment vendors, or where appropriate, supplied to end users for development of their own applications. The two main players within this group are SunNet Manager and HP OpenView, both of which are covered in more detail below. It should be noted that IBM's NetView/6000, which is based on HP OpenView, is another key contender.

Key Management Environments

SunNet Manager

Essentially, SunNet Manager is a management environment providing a platform on which to build management applications. Developed by Sun Connect (as opposed to Sun Microsystems), SunNet Manager is resold through distribution channels, some offer the added benefit of full support and integration services.

The core SunNet Manager software is delivered with a set of user tools, management services and agents for TCP/IP and Ether net networks. This can then be extended to incorporate DECnet, FDDI and NetView. The user tools include: discover tool, request builder, event reporting, and grapher. Overall, the software is recognised as being a mature and increasingly widely adopted platform. There is no doubt though, that this is in part due to the software being given away at a greatly reduced price (if not free in some cases) with Sun hardware in certain market sectors, such as education. In these cases, the incentive to implement a SunNet Manager based management solution is therefore that much greater.

SunNet Manager has been adopted by a significant number of vendors who have written their own management applications. The number is in excess of 60 to date, including Cisco, Chipcom, Xyplex, 3Com, Cabletron, Isicad, Remedy and SAS.

Although the software is used widely, there are some issues which should be highlighted. First, the fact that the implementation and subsequent upgrades to a management system depend on two suppliers. This inevitably creates difficulties in keeping both SunNet Manager and the product application in step with each other. Already there has been the situation where applications still utilise Version 1.2 rather than Version 2.0 of SunNet Manager. This is expected to be further compounded when Sun migrates to the Solaris 2.0 operating system. However, Sun claims that this latter problem will be significantly diminished with Solaris 2.3, which should enable most Solaris 1.0 applications to run unchanged.

It should also be noted that because SunNet Manager applications are developed by different suppliers, the look and feel of each user interface is different as users navigate through the system. There is not the same continuity, therefore, that is offered by products such as Network Managers' NMC 3000 and Cabletron's Spectrum, for example, see Figure 2.

A third issue is wide variation in the price of product applications, which in part, reflects the complexity of the equipment involved (e.g., a router as opposed to a bridge), but could also indicate the level of functionality included within the application. There is a need to monitor and track standards, although they are in a state of flux. There has been a lot of confusion about Sun and its involvement in long term plans in the area of DME (more on this later). It has appeared that SunNet Manager lost momentum in this area because of the push for DME by Hewlett Packard, IBM and others. Further, Sun compounded its directions by not making any statements about its commitment to Omnipoint (also, see later).

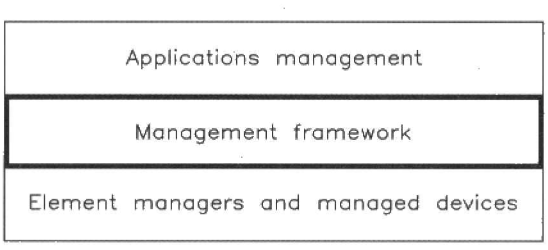
With reference to the Motif user interface technology, Sun was once part of UNIX International (UI) which is in direct competition with the Open Software Foundation (OSF) standards body. UI is also involved in getting technologies adopted as *de facto* standards. Sun's contribution to the UI has been OpenLook, a user interface which has not taken off in the same way as X.Windows and Motif. It may be indicative, therefore, that (as of Spring/Summer 1994) Sun has opted out of UI and dropped OpenLook in favour of Motif.

HP OpenView

The other key management environment that should be mentioned, is OpenView, which is Hewlett Packard's strategy for OSI based management. Like SunNet Manager, OpenView can be regarded as a development platform on which vendors and end users build their own applications. Unlike SunNet Manager, however, OpenView is available as either a DOS or UNIX application.

Management solutions based on OpenView also include applications

Figure 2.



Systems management sandwich–
no products have yet made the transition from the network management focus to applications management. They represent the 'filling of the sandwich' shown here.

developed by HP for their own product set. Specifically, these are: OV Hub Manager (DOS), OV Interconnect Manager (DOS, HP and Sun SPARC platform), and OV Resource Manager (DOS). HP also provides a variety of different packages which can be provided on an OEM basis to equipment suppliers and users, depending on the required functionality and the level of expertise available in-house. These include:

- Developer products (HP and Sun SPARC platform)
- Developer platforms (HP and Sun SPARC platform)
- OV Extensible SNMP agent (HP and Sun SPARC platform), used for extending the Sun or HP management agents.
- OV Management Station (HP Platform) bundled software and hardware end user package. Includes Network Node Manager.
- OV Network Node Manager (HP and Sun SPARC platform), includes application builder for end user development without requiring detailed programming knowledge
- TCP/IP agent (HP and Sun SPARC platform), enables SNMP management of HP or Sun SPARCs
- OV Windows/DOS OEM development environment.

Included in the list of suppliers who have adopted HP OpenView, are Wellfleet, Xyplex, Spider, Isicad, Remedy, Hughes, Cabletron and IBM, which has based its NetView/6000 application on Network Node Manager. Also, Digital dropped its own management platform, DECmcc, for NetView/6000.

Future of the Management Arena

As has become evident, SNMP is here now, and is likely to remain for the foreseeable future. This can be attributed to a number of reasons, not least, the emergence of SNMPv2, which addresses some of the shortcomings and effectively stalls the need to migrate to the Common Management Information Protocol (CMIP). At the same time, CMIP by its very nature, is unlikely to exist in isolation, as it is both complex and bulky (and therefore costly) to implement.

It is believed that CMIP may be reserved for critical devices in a network such as backbone routers, whilst workgroup hubs, for example, will continue to support SNMP. This will be reflected in the management stations themselves, which will have dual support for both CMIP and SNMP.

Another reason for the prolonged life of SNMP is the rise of the RMON (Remote Monitoring Management Information Base) and other standard MIBs (such as chassis, FDDI and serial port), which will alleviate the problem of bandwidth loading caused by the central collation of device information. But, as a standard MIB, RMON's only benefit is to ensure that equipment vendors implement a common base of features. The use of standard MIBs inevitably means that the cost of management applications and upgrade delays will be reduced, while user interfaces become more consistent. RMON is covered in more detail later.

It is interesting to note that in one Datapro survey, it has been projected that it is CMIP which (proportionately) will demonstrate the most significant growth, increasing from 4% in 1992 to 26% in 1995. In the same survey, a marked increase in integrated LAN/WAN and SNMP based internetwork management systems is also forecast. While many informed pundits concur with the latter view, it is felt that CMIP take up within the UK market will be significantly lower than the projected 26%, as SNMP is enhanced and the traditionally proprietary WAN marketplace moves towards the use of SNMP agents or proxy management applications.

Outside the specific area of management protocols, there are a number of other pertinent developments taking place. Specifically, these include the Distributed Management Environment (DME), the draft framework for which was proposed by the Open Software Foundation (OSF) in 1991. It was established as a result of a Request For Technology, to which 41 organisations responded and a subsequent 27 were chosen contributors, including IBM, HP, Tivoli and Groupe Bull.

DME is designed to address the problems of managing large, interconnected, heterogeneous networks, by providing a consistent high-level interface to managed devices and networks. DME defines a framework to enable both systems and network management to benefit from the concepts of distributed computing.

There are three basic goals of DME: interoperability of platforms and applications; consistency of user interface and application integration; and scalability, which means that the performance of management systems will not be affected by the number of managed elements on the network. As potentially the most significant step in the standardisation of management software, DME should simplify the initial choice of a management system, and ensure that the way is left open for future growth and integration.

However, ratification of DME and draft standards have been somewhat elusive characteristics. Realistic benefits are unlikely to be apparent for some years. Certain organisations, such as HP, are promoting their plans for migration to DME. However, HP is one of the original organisations chosen to contribute technology to the DME architecture. For a while, people could be forgiven for thinking that HP was DME.

However, in mid-1994, enthusiasm for DME was on the wane, as a number of suppliers declared developments were too uncertain and futuristic. Another development which has become increasingly important, is the Remote Monitoring (RMON) Management Information Base (MIB), already referred to above. The RMON MIB is a standard which has emerged to address some of the shortcomings of the SNMP management protocol in both Ethernet and Token Ring environments. The focus is on data collection and analysis. Although some features exist already within certain vendor private MIB extensions, RMON standardises these and provides functional, and performance improvements. Essentially, RMON is implemented as a standard network remote monitoring device specifying nine functional management groups, of which all or only a selected subset need be implemented on equipment. They are:

Segment Statistics	Host Table
Filters	Events
Host Top N	History
Alarms	Packet Capture
	Traffic Matrix

To comply, implementations of RMON need not include all the groups listed above, but must include all 'objects' within selected groups.

Remote Monitoring devices typically provide configuration information for network tuning, and as such, do not replace protocol analysers, which focus more on the supply of diagnostic information for fault correction. RMON can be implemented either on standalone units (such as HP LANprobe or NAT Ethermeter) or integrated into other networking equipment such as hubs which support a management agent. An increasing number of equipment manufacturers are now providing integrated RMON support into their equipment. This, to a large degree, can be attributed to the use of high-performance chip sets.

RMON was defined by the Internet Engineering Task Force (IETF) who are responsible for adding future capabilities. RMON addresses Ethernet and Token Ring networks, although extensions for FDDI are to follow. With Token Ring, a 10th group was specified to address beaconing.

An additional group whose actions affect the marketplace, is the Network Management Forum (NMF) set up in 1988 as a consortium of carriers and communications equipment suppliers. The original aim of the consortium was to act as a catalyst in the migration to open network management systems, using OSI management standards where appropriate. At the same time, the aim has been to disband the organisation when their goals have been achieved.

As well as accelerating the progress of management standards development, implementation, testing and interoperability, the NMF has also established the OMNIpoint partnership to ensure that all the relevant groups converge their efforts to a single management goal. To that end, they have released a publication, also called OMNIpoint, which lays down sets of guidelines for vendors to adhere to in product development. OMNIpoint is likely to be backed by Government and major corporates alike.

Interestingly, the NMF has always acknowledged the real world problems facing network managers, i.e. they see CMIP as just one of several protocols necessary to provide effective network management in a multivendor environment.

The Telecommunications Management Network (TMN) is a set of CCITT defined standards that describe the architecture for the management of telecommunications networks. Increasingly, however, it is being positioned to address the management of both wide area network (WAN) and local area network (LAN). The TMN complements the work being done by the

NMF, but it is likely to be several years before a complete management system is available in product form.

Making the Choice

There is no easy answer when it comes to choosing a network management system, but as a guide, there are a number of key questions that need to be considered:

- What aspects of the network are to be managed – LAN and/or WAN?
- What specific equipment (type and model) require management? (e.g., if Cisco, is it a CGS, MGS, AGS+, etc.?)
- How many devices (approximately) are to be managed?
- Where are the devices located?
- Is there a preference for a PC or UNIX platform?
- Are any management applications already in use?
- Are there staff already familiar with any management systems?
- Are there any staff already in place to administer the system and if so, are their skill sets applicable?
- Are there existing Help Desk procedures in place, and how will they interact with a network management system?
- Is multiple user access required to the management system?
- What functionality has to be achieved from a management system – configuration control, fault notification/ management, statistics collection/analysis, network monitoring, load analysis (i.e. 'what if' scenarios), cable management, trouble ticketing?
- What are the timescales and budget for the implementation of a management system?

As well as the above, there are also a number of issues that should be addressed when looking at a potential supplier, including: supplier stability; experience pedigree in the networking arena and specifically, within network management; ability to provide ongoing support for the chosen system; commitment to continue with product enhancement/development; commitment to incorporate new standards and technologies; awareness of the competition in the network management marketplace; and neutrality – do they have a stronger allegiance to a particular product set?

Choice of Standards

Standards are a major concern. Currently, SNMP is regarded as the industry de facto management protocol, although a migration to OSI's CMIP is envisaged over the next few years. There are in addition, other management protocols outside the LAN arena which need to be handled by a management station (e.g. FDDI, frame relay). Any system selected should be capable of supporting such multiple protocols simultaneously. Standards also relate to system architecture. There is an increasing trend towards distributed management of both networks and systems, which has been reflected in the definition of Distributed Management Environment (DME). While this has not yet been ratified, a number of suppliers have been identified as being contributors to the DME architecture through the products that they offer.

A further consideration is the significant number of suppliers providing management systems, many of which are promoted as offering full SNMP management control. However, caution is required, as all too many of these provide comprehensive SNMP management for a particular product range and only limited or generic support for third party devices. In choosing a network management system, users need to be aware of the differences between such element systems and those offering true enterprise management.

Similarly, product scalability should be considered as key, both in terms of supporting an expanding network as well as any additional functionality which enhances the existing management features. In particular, this may include advanced reporting and analytical tools, or perhaps the ability to incorporate cable management.

Much interest is being shown in Artificial Intelligence (AI) in network management, particularly in the area of fault-finding and troubleshooting. In many cases, management systems generate alarms for every fault on the network, which not only fills up the alarm log, but also hinders the task of fault location. In the future, the role of AI will become increasingly important, and it could one day be that AI not only provides fault finding tools, but also enables a management system to take subsequent corrective action.

Summary

The area of network management is a potential minefield, and it should not be assumed that an 'off the shelf' system will fulfil a user's needs without tailoring. But this is not to say that customers cannot meet the majority of their management requirements via pre-packaged products. Most systems have impressive graphical interfaces at a surface level, but for multi-vendor environments, a check needs to be made for the degree of support for 'alien' devices and whether the interface remains consistent.

Users need to consider what applications they wish to build on top of operational control, and to look for SNMP support, including the RMON MIB, while asking questions about DME and CMIP to gauge future commitments. The point needs to be made, that it is not the management system itself that manages networks, but the people who administer the system – the management system is there as a tool to facilitate this. In any case, users have to ensure their expectations of network management are realistic.

A PRACTICAL GUIDE TO MODERN DIGITAL ICs – *Continued from page 55.*

Figure 18 shows the typical short-circuit output currents of 'standard' and 'bus driver' versions of '74HC-series' CMOS output stages over the 2 to 6V operating voltage range; in practice, the maximum DC values of these currents must be limited to 25mA in 'standard' HC types, and 35mA in 'bus driver' HC types.

The only time this 'current limiting' matter is likely to present any kind of problem, is when using CMOS to drive some type of LED load (including those at the inputs of opto-couplers, etc.). Figures 19 and 20 show basic ways of driving a LED via non-inverting or inverting CMOS elements. Note in these circuits, that R1 sets the LED's ON current, and has a value of $[(V_+ - V_s)/I] - R_x$, where V_+ is the supply voltage, V_s is the LED's saturation voltage (typically 2·0 to 2·5V), I is the LED's ON current (in amps), and R_x is the CMOS element's saturation resistance (which varies widely with voltage, current, and with individual ICs). Typically, however, V_s equals 2·2V, and R_x has an approximate value of 100Ω in a standard 74HC output, 70Ω in a bus driver output, or 500Ω in a standard 4000B output. Thus, to set the LED current at 10mA, R1 needs a value of about 180Ω in a 5V standard 74HC circuit, 220Ω in a 5V bus driver 74HC circuit, 270Ω in a 10V 4000B circuit, or 820Ω in a 15V 4000B circuit.

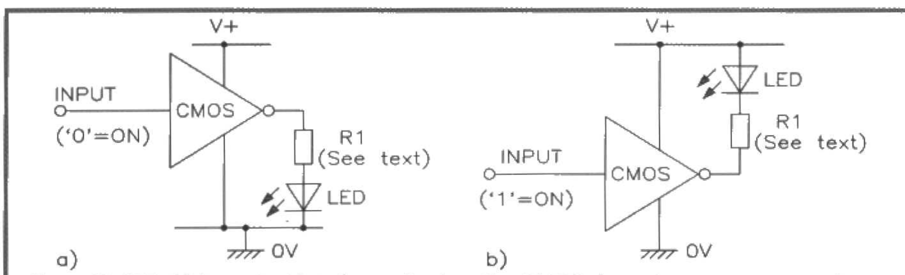


Figure 20. LED-driving output interface, using inverting CMOS elements.

Logic Family Interfacing

It is generally bad practice to mix different logic families in any system, but on those occasions where it does occur, the mix is usually made between TTL and CMOS devices; Figures 18 to 21 in Part 3 of this series showed six basic ways of interfacing TTL and CMOS ICs. Note that 74HCT and 74ACT types of CMOS IC are designed to be directly driven from TTL outputs, without need for special interfacing methods. Also note that standard 4000B-series and 74CXX-series CMOS elements have very low fan-outs and can only drive a single Standard TTL or LS TTL element, but 74HCXX-series (and 74ACXX-series) CMOS elements have excellent fan-outs and can directly drive up to 2 Standard TTL inputs, 10 LS TTL inputs, or 20 ALS TTL inputs. Next month Part 5 describes the practical applications of the popular 4007UB CMOS IC – a complementary pair plus inverter, dual buffer chip.

Dear Editor

AIR YOUR VIEWS

Interfacing Update 1

Dear Editor,
In his letter in issue 95, Ken Hughes comments that the Amstrad 8256 does not have a Centronics interface, and hence, he has been unable to check out the IBM PC Centronics Input Port in this case. It is many years since I had an 8256, but I am sure that there was at least one serial/RS232 interface available for it (from Silica City?) and I thought that there was also the parallel equivalent. But if not, then given a serial output, it should not be too difficult to convert to parallel. One obvious thought is to use one of the various serial-to-parallel interfaces created for the Sinclair Spectrum and QL. I have two, one made by Miracle Systems, and the other by Technology Research.
Alan D. Cox, St. Clears, Dyfed.

Interfacing Update 2

Dear Sir,
Further to my previous letter (see issue 95 – Ed.), I should be grateful if paragraph 6 could be amended to read as follows:
6. Amstrad 8256 to IBM (e.g., 3in. to 3·5in. disks data) – Cirtech make a small bolt-on Centronics interface, which works with CP/M software, version 1.12 onwards. I must apologise for this change, but I have now found the answer to my original queries.
Ken Hughes, Wokingham, Berkshire.

Thank you both for writing in to supply this information, which I'm sure will be of value to all the Amstrad 8256 owners out there!

Two-in-one, But Can it be Done?

Dear Sir, I just received the October 1995 issue of *Electronics*, and found with interest, your article on the PC Teletext Decoder project. I was one of the first subscribers to build the NICAM television tuner. It is still giving sterling service today, and has been used continuously ever since. Do you have a Teletext decoder to fit inside the NICAM tuner? Although I continued my subscription, I have been working abroad these last few years, and so I have a lot of reading to catch up on, as the postage rates were excessive, so my wife kept all copies of your magazine intact until I returned home. Failing the above request, if I invest in the PC Teletext Decoder, I would want to interface it with the NICAM decoder. I would be grateful if you can advise the take-off points on the NICAM decoder, to interface it with the Teletext Decoder. I am not a technician, but have built many of your kits and enjoyed them all.
Ken G. Dyer, Swansea, West Glamorgan, Wales.

According to the project developer, Chris Barlow, who designed the NICAM television tuner module (part of which is similar to the PC Teletext Decoder Tuner Module, although there are many detail differences), it would be difficult to interface the NICAM tuner to the PC Teletext Decoder system, since the computer is used to generate, via the PC Teletext Decoder Interface Card, a tuning voltage to provide an automatic scan of the tuning scale. A PC interface and DC-DC converter are required to achieve this, which are built into the Interface Card, and the PC Teletext Decoder Tuner Module has corresponding circuitry to accept this tuning voltage in order to set the channel. Unfortunately, attempting to add the Teletext Decoder circuitry could also have undesirable affects on the operation of the NICAM tuner, so we would not advise doing so; since the Tuner Module is a relatively inexpensive and easy-to-build part of the PC Teletext Decoder system, it would probably be a false economy not to build the separate, purpose-designed module to complement the Interface Card and software.

S·T·A·R L·E·T·T·E·R

In this issue, Malcolm Perry, from Kidderminster in Worcester, wins the Star Letter Award of a Maplin £5 Gift Token, for his comments on the Mains Failure Alarm.

£5 Gift Token

★★★★★★★★★★★★★★★★★★★★★

Dear Sir,
I was extremely interested in the circuit of the Mains Failure Alarm in the November issue of *Electronics*, especially the methods of obtaining the low-voltage and charging the Ni-Cd battery. Recently, I have come across this method a number of times in commercial equipment, where the mains voltage is reduced using a simple resistor or capacitor as a series voltage dropper, bridge rectifier and rechargeable battery. This low voltage then supplies the electronics. There has been the problem that these circuits rely upon the low internal resistance of the battery to give the correct operating conditions. However, with time, the battery resistance increases, and therefore, the voltage across it also increases, until it eventually exceeds safe levels, causing the units to fail in an expensive way as the ICs become damaged. I began to wonder why the circuit did not include a Zener diode to hold the voltage down in case of battery failure. I see the Maplin circuit does include a Zener, hence the problems mentioned would not arise, as the output of the rectifier is held at the correct voltage, irrespective of battery condition. Let's hope that those manufacturers read Electronics and take note! Seems silly, risking expensive equipment for the sake of a few pence component.

Congratulations on your observant reading of the circuit diagram published for this project! As you say, it seems folly to omit an inexpensive component in a design, when its inclusion will prevent damage to the rest of the circuit, but then, in order to be competitive, some manufacturers prefer to build a device down to a cost, rather than up to a good standard, particularly if they can still make the product outlast a reasonable guarantee period, such as the lifetime of a typical Ni-Cd cell. What happens to the unit after that period is none of their concern in most cases!

★★★★★★★★★★★★★★★★★★★★★

What Source!

Dear Sir,
I was particularly interested in the PC Teletext Decoder project in the October 1995 issue of Electronics. However, I would like to know whether the software supplied with the kit also includes source code (and if not, why not?), and whether the schematics for the internals of the XC3020 are also available. I think both of these things may be of interest to readers, and in particular, the Windows source code may be of some use to people trying to program for Windows (I've been reading about this recently, and I'm totally confused). The use of the Xilinx programmable FPGA is new to your project designs, and I am curious why you have adopted it (I think it's a very good idea though). I have had experience of using XC4024 devices in a group project at UMIST, where we were synthesising designs using VHDL and downloading them using a microcontroller (the idea being that we could change the operation of the Xilinx chip and get it to do some 'useful' work, depending on the program). The board we used for the project utilised an MC68332 microcontroller, Flex logic devices (another type of FPGA), as well as the Xilinx chip. Practically everything could, therefore, be 'programmed', and changed in a variety of ways – for example, the 68332 contains a programmable timer module (TPU – Timer Processor Unit), which can not only carry out several timing related functions, but can also have these totally reprogrammed by downloading a new microcode ROM image. Overall, the system was extremely flexible, and none of the devices was hardcoded in any way – everything could be reconfigured at any time. I think that devices such as the 68332 and Xilinx chips could make excellent components for future projects – not only do they provide very powerful features, but they are totally reprogrammable and could be reused in different projects. They could also be useful in allowing hobbyists to produce fairly complicated projects without the need to resort to hardwired, special purpose VLSI/LSI chips (I don't like these, because you cannot take them apart' to find out how they work!)
A. Bianchi, Insignia Solutions Plc, High Wycombe, Buckinghamshire.

Good to hear that you found the PC Teletext Decoder project of interest – a lot of work went into developing and producing it! The original design was by Tony Williams, who is an engineer at Xilinx, hence the use of the Xilinx XC3020 FPGA! Regrettably, we cannot disclose the source code programmed into this IC – rather like the PIC-based projects, disclosure of the program is up to the discretion of the designer. For schematics of the XC3020 internals, you will need to contact Xilinx direct, Tel: (01932) 349401.

Noise – Part 1 Corrections

My attention has been drawn by Mr. M. White of Malvern, Worcester, and Mr. R. Sharp of St. Austell, Cornwall, to the need for some corrections to my article 'Noise – Part 1' (Issue 91 – Ed.), as follows:
1. The odds against getting 5,000 heads in 10,000 tosses of a fair coin are close to 124:1. The 0·4 result given in the text for probability should be denormalized by dividing by 50, which is the value of the standard deviation in this case, giving 1/125.
2. In the fourth column on page 37, there should not be an integral sign in the seventh equation (where Γ first appears).
3. Near the foot of that column, the equation should read: $\Gamma(n)=(n-1)\Gamma(n-1)$.
4. In the second column of page 38, the second term on the right-hand side of the first equation for V_n^2 should have 1 in the numerator instead of *R*, so that R^2 in the following becomes just *R*. But the final result is correct.
5. In column 3 on page 38, the equation for f_{-3dB} has a μ in the denominator, which should be π.
6. At the foot of the second column on page 39, the denominator should read: $R_l^2 + R_s^2 + 4\pi^2 f^2 L_s^2$.

I thank the correspondents for their interest and diligence.
John Woodgate, Rayleigh, Essex.

Active Aerial Alterations

Dear Sir,
In the instructions for the Active Aerial kit, it has been suggested that the use of a conformal spray coating would reduce the risks of insect attack, corrosion and dirt from attacking the preamp board in the base aluminium tube. As good as the conformal coating is, it has been my experience that dirt and insects can still be a problem. I only became aware of this one day, when looking at the roof of my house through binoculars, and noticed wasps entering and leaving the base of the unit. They were feeding off of micro-sized flies that had infested the interior of the tubing. A cheap modification can be carried out to the unit, which will minimise attack by foreign bodies, and which will provide additional protection other than the

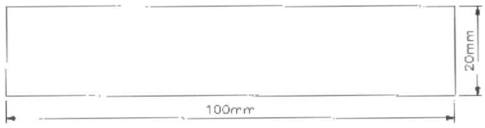


Figure 1.

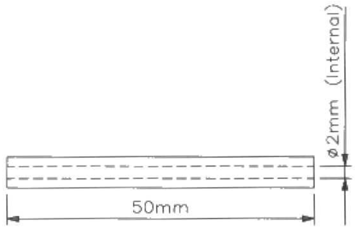


Figure 2.

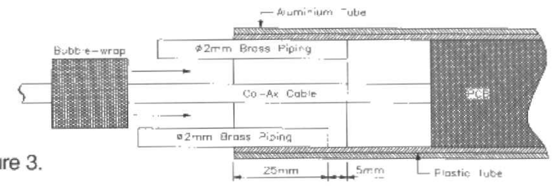


Figure 3.

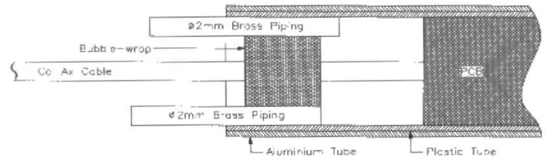


Figure 4.

spray coating on the PCB. Firstly, take a piece of bubble-wrap packing from your last Maplin order, and cut out a 100 × 20mm piece (see Figure 1). This acts as the tube plug protection. Bubble-wrap is best, as it is easily compressed and moulded into shape. On a visit to any decent model or hardware shop, buy a small length of 2mm internal diameter brass piping. Cut two 50mm lengths (see Figure 2), and clean off any burrs on each end. 2mm is an optimum size, as it allows air into the base of the tube, but keeps insects and water out. The tube also allows air pressure equalisation, and if the heat-shrink cap springs a leak, allows water to escape through the base unit. Using Araldite or similar, fix one drain tube to the inside of the aluminium tube. A minimum of 25mm of drain tube must be inside the aluminium tube. The second drain tube is fitted directly opposite the first, but must be fitted 5mm deeper than the first drain tube. This allows air to enter on one side of the base unit as any collected water on the other drains out. Put aside to allow the adhesive to set. Next, take the cut bubble-wrap, and slowly wrap it around the coax lead in a tight circle (see Figure 3). Make sure that you can slide the plug of bubble-wrap easily up and down the coax cable. If not, unwind and rewrap. There should be enough friction to make a seal, but not so much that you cannot slide it into the base unit. Referring to Figure 4, slide the bubblewrap up the coax cable, and using the end of a paintbrush or tablespoon handle, gently prise the bubble-wrap plug into the base of the aluminium tube, making sure that the two drainage tubes are not dislodged. When in place, the plug must be recessed into the base by 5mm, so that tube 1's outlet is flush with the inside of the plug. Finally, ensure that the plug will not escape, and install the unit back on the roof. Any collected water through leaks will be removed by the drainage tubes. Insects will not be able to enter the unit, and air will circulate via the two drainage tubes, to keep internal and external air pressures equalised.

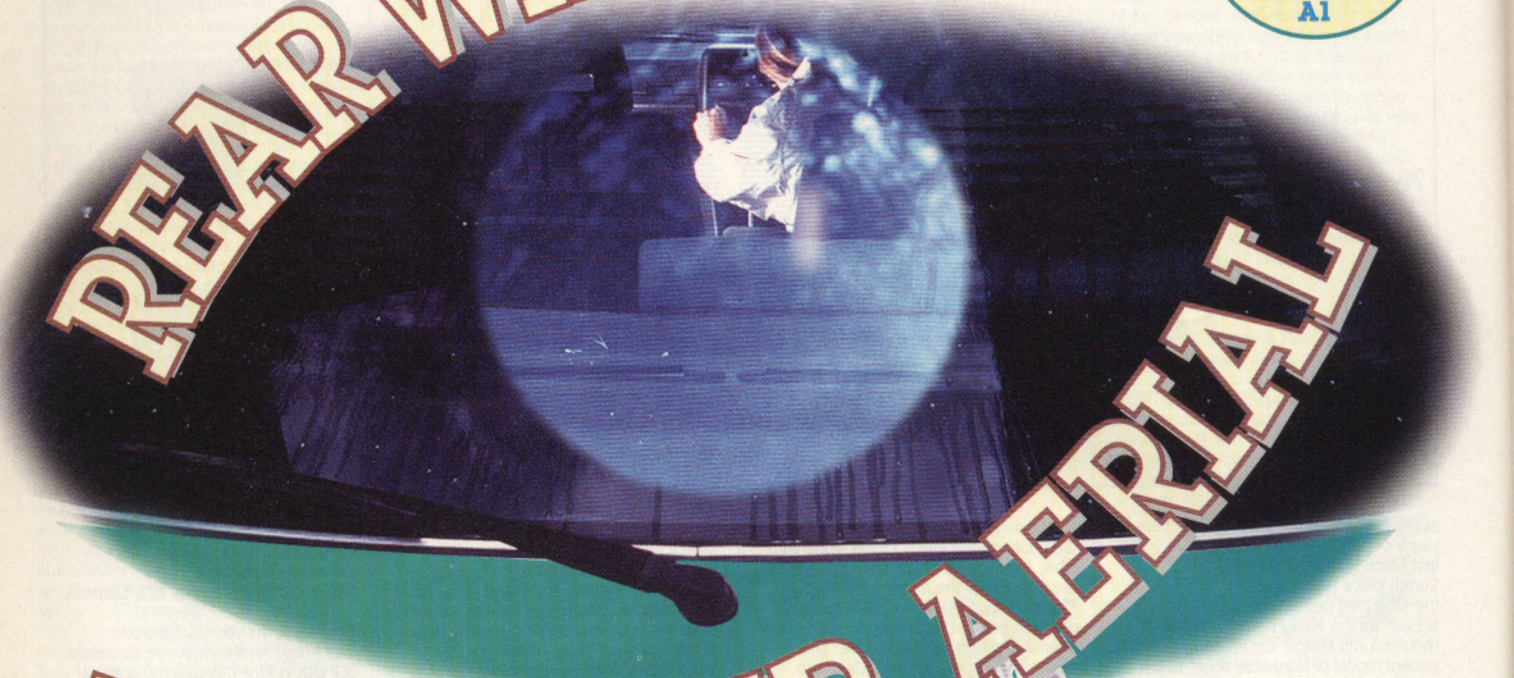
Mr. P. Hubbard, Herne Hill, London.

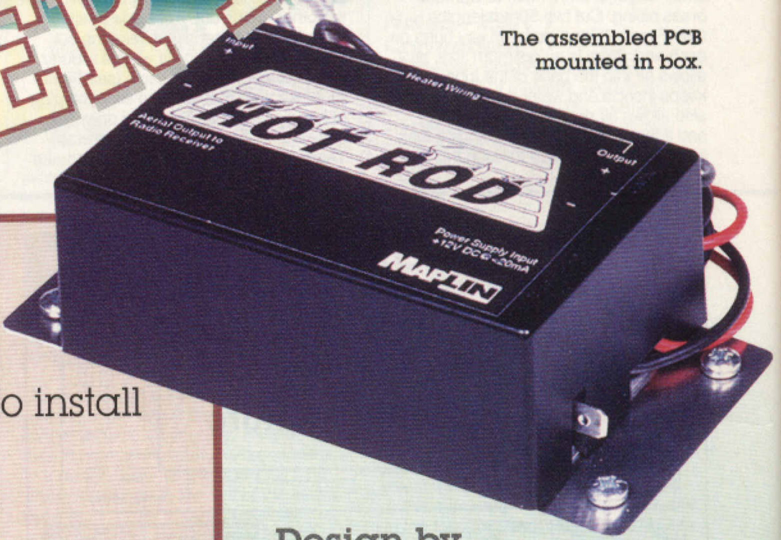
Thank you for your suggestions. The article for the Active Aerial (issue 89) did, in fact, mention using some form of packing material after having pushed the coax and connections into the body of the aerial, although the exact form of this was left to the constructor. It all depends really on where the aerial is to be fitted, and upon the likely weather conditions and insect population of the surroundings!

2
PROJECT RATING

KIT AVAILABLE (90065)
PRICE £24.99
A1

REAR WINDOW DEMISTER AERIAL





The assembled PCB mounted in box.

FEATURES

- Excellent FM/AM coverage
- Compact, robust design
- Easy to install

APPLICATIONS

- Ideal for cherished cars and vans
- Ideal for Customised and Classic vehicles

Design by Alan Williamson
Text by Alan Williamson and Maurice Hunt

This project is intended for discerning motorists who do not wish to damage their car bodywork by drilling a hole to fit a conventional extendable rod-type antenna, or for those people who are fed up with their existing aerial being vandalised when it has been inadvertently left extended. There are also additional drawbacks to using a conventional aerial, including the formation of a known rust-prone area (holes and fittings encourage corrosion), and the aesthetic appeal of the vehicle may be spoilt by having an unsightly rod aerial on view.

The demister aerial is perfect for those painstakingly restored classic cars (which may not have had an aerial fitted originally, but whose owners wish to fit radio equipment), custom cars, or as a neat addition to any (negative-earthed) vehicle. This project is also suitable for vehicles of glassfibre body construction, or even Kevlar/carbon fibre. If you happen to be the owner of a McLaren F1, the fastest and most expensive production car in the world, which incidentally, is not fitted with a radio as standard! Another bonus from a security point of view, is that by installing this aerial does not advertise the fact that you have a stereo fitted, since there would be no aerial visible!

This is a useful and viable alternative to an automatic aerial when used for FM reception (in fact, the prototype unit could pick up distant FM stations that a conventional rod aerial couldn't!), and the rear window aerial amplifier will be just as effective even if the heater element doesn't work. The amplifier will also pick up the Medium and Long wave AM bands; however, cars are notoriously electrically noisy. The sharp rise time of the ignition and the alternator make rather good RF transmitters, whose bandwidth extends well above 1MHz. Due to the nature of the close proximity of the rear window to the bodywork and its high (RF) impedance, the amplifier is also rather good at picking up this

Note: This project is suitable for negative-earthed vehicles only.

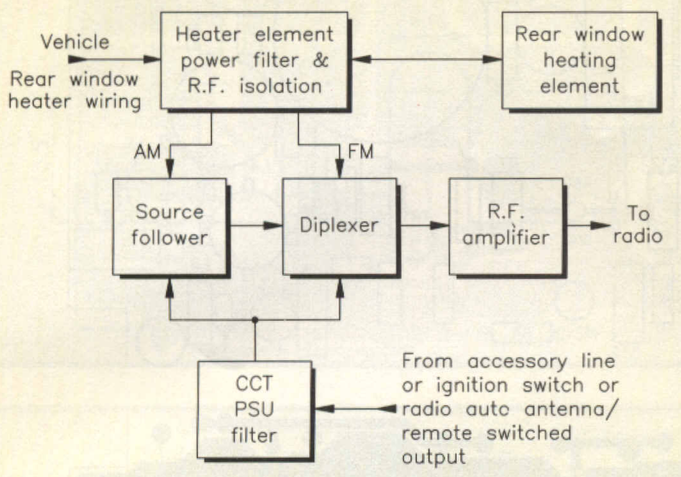
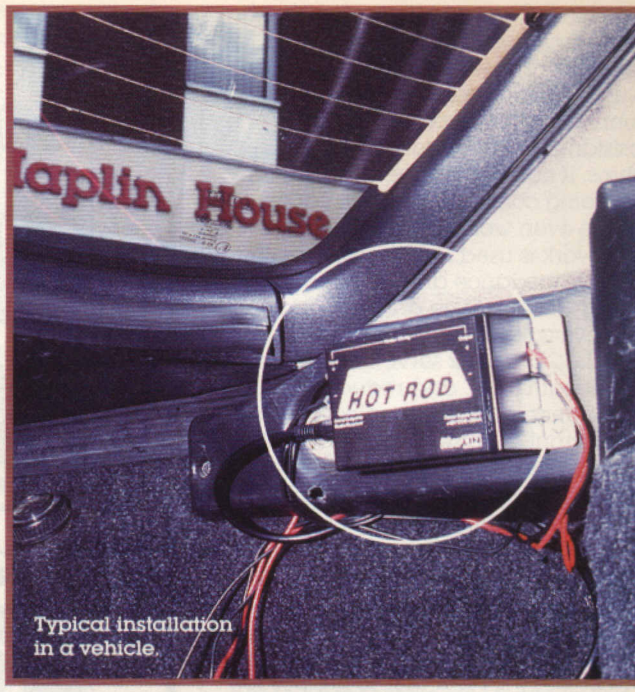


Figure 1. Block diagram of the Rear Window Demister Aerial.



Typical installation in a vehicle.

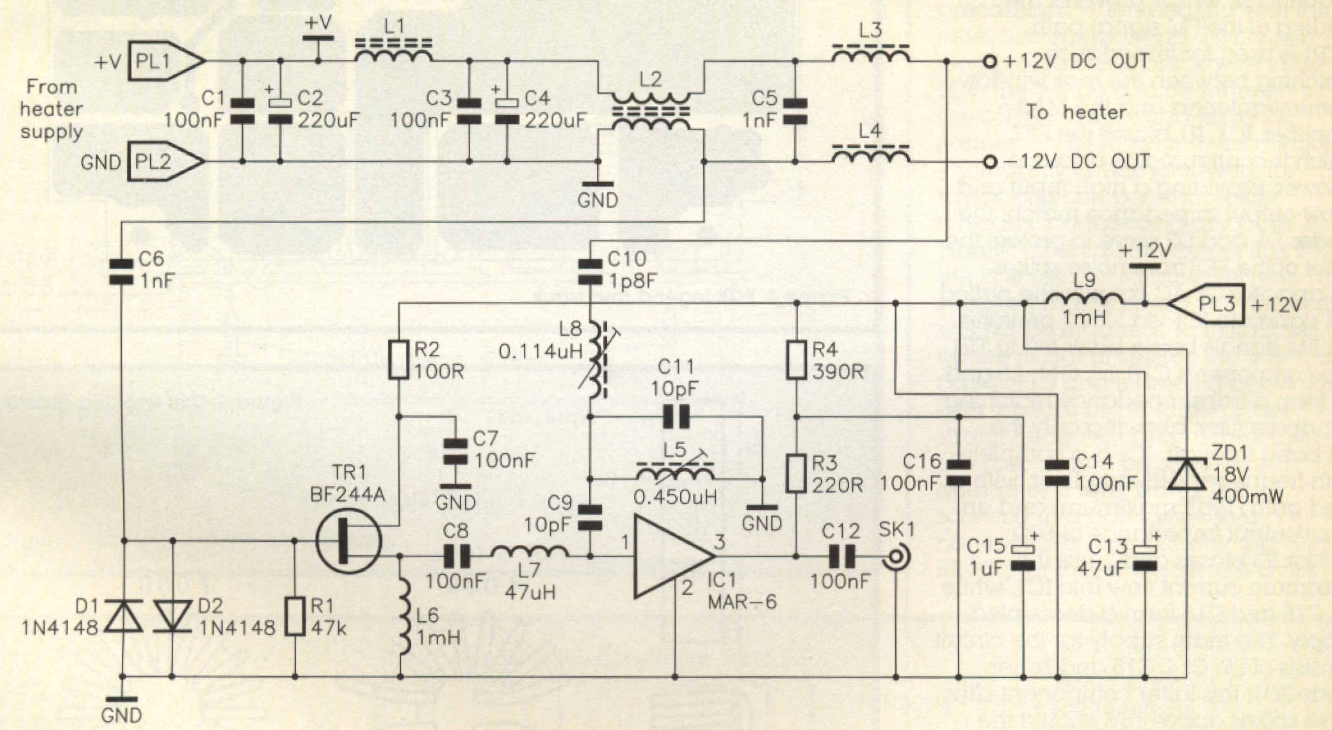


Figure 2. Circuit diagram of the Rear Window Demister Aerial.

interference in the AM bands, unless the vehicle is suitably suppressed.

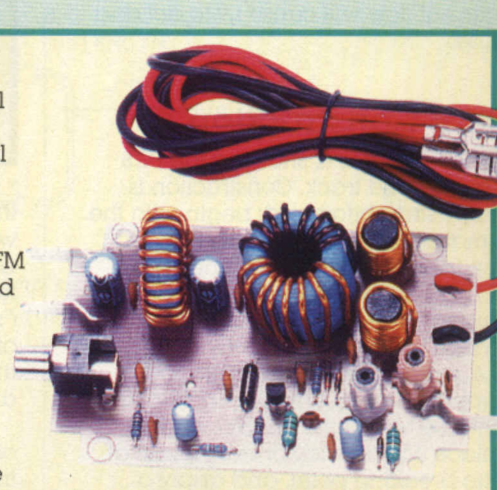
If interference is a problem, consult a qualified car electrical systems engineer. Fading of distant or low power stations (especially in hilly areas) or passing high mass buildings (or ones with a high steel content) may be experienced, or when the heater element intersects at right angles to the propagation path.

Circuit Description

Refer to the block and circuit diagrams of the circuit, shown in Figures 1 and 2, respectively. Capacitors C1 and C2 in theory should not be necessary (because the car battery is effectively near short

Specification

Supply voltage:	12V DC nominal
Current consumption:	17·4mA nominal 22·6mA @ 15V
Overall gain:	19dB
Spectral response:	All UK AM and FM radio waveband frequencies
Heater element current:	15A maximum, 50% duty cycle rated 8A continuous, 100% duty cycle rated



Assembled PCB.

circuit to AC signals). However, due to the length of the rear window heater wiring, which has impedance, plus the added resistance of the connectors, the impedance (not resistance) may be several tens of Ohms, if not higher (due to corrosion of ageing connectors); the situation will be even worse if the vehicle's bodywork is used for the return path.

The impedance and length of the wiring will act as an antenna, picking up any radiated stray electrical signals. C1 and C2 serve as a short circuit path to AC and reduce the impedance. L1 helps to reject the throughput of noise, while C3 and C4 reduce the supply impedance even further. L2 is a bifilar wound choke; the bifilar winding helps to prevent saturation of the core material, as well as lifting the L4 end away from the chassis.

Capacitor C5 provides a short circuit path for RF signals, while L4 and L5 are the final output chokes to the heater; the function of the chokes is to increase the impedance at VHF frequencies, which prevents the loading of the FM signal path.

TR1 is used for impedance matching between the rear window element/antenna and the MAR-6 amplifier, IC1. R1 biases the FET, which is configured as a source follower, providing a high input and a low output impedance match; the diodes D1 and D2 serve to protect the input of the FET from noise spikes.

Capacitor C8 AC couples the buffed AM signals to IC1 via L7; L7 prevents the FM signals being back-fed to TR1. The components C10, L8, C11, L5 and C9 form a transimpedance matching bandpass filter, allowing only the FM band through. IC1 is a complete high-frequency (HF) amplifier, with a fixed gain (19dB maximum) and an input/output impedance of 50Ω; resistor R3 biases and limits the maximum current flow into IC1, while R4, C15 and C16 form a decoupled supply. The main supply for the circuit consists of L9, C14, C15 and Zener diode ZD1; this latter component clips noise spikes above 18V. Should the supply be inadvertently applied with the wrong polarity, ZD1 will clamp the supply to <1V, and the resulting large current flow will cause L9 to act as a fuse.

PCB Construction

Refer to Figure 3, showing the PCB legend and track. Construction is fairly straightforward; begin with the smallest components first, working up in size to the largest. The coils L1, L2, L3 and L4 will have to be manufactured, see Figure 4. To make the formers for coils L3 and L4, use two lengths of ferrite rod, approximately 17mm long, first score the rod with a file or similar, then place it into a vice or over a nail at the breaking point, and apply a reasonable force to snap the rod. A helpful tip, is to begin winding from the middle of the length of wire, working outward towards the ends. Glue the three torroids together with a few drops of cyanoacrylate adhesive ('superglue'), to make the central core of L2, and also use the glue to secure the ferrite rod sections into coils L3 and L4.

Note, the direction and number of turns of each winding on L2 is important, to prevent saturation of the core. Take care not to scratch the enamel off the copper wire when

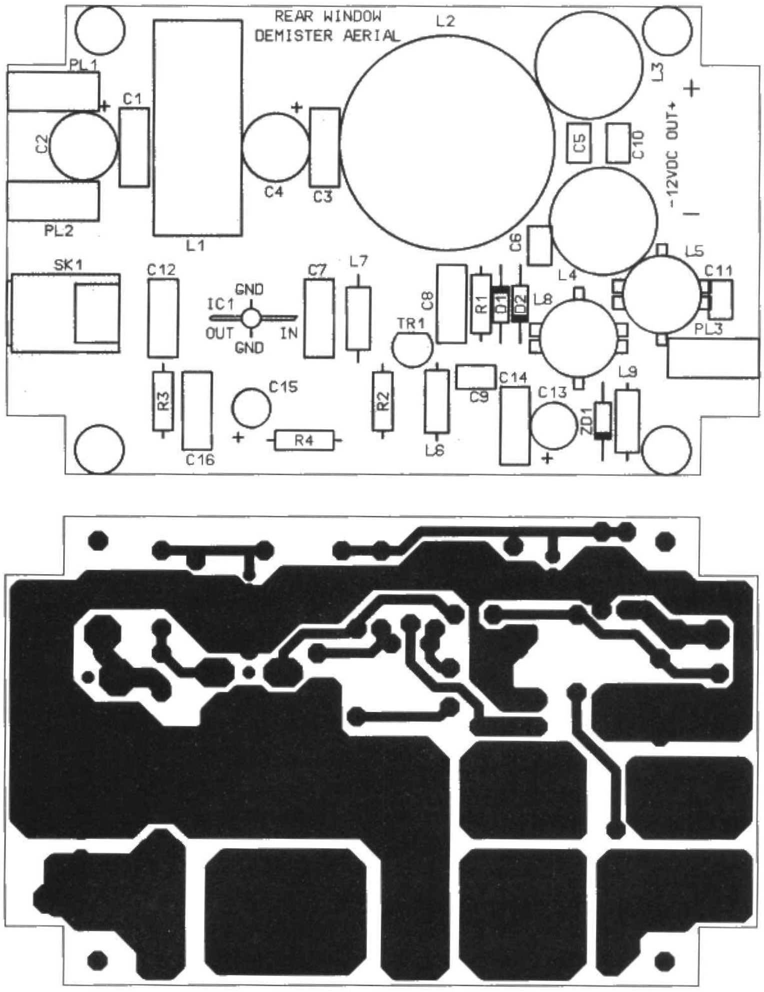


Figure 3. PCB legend and track.

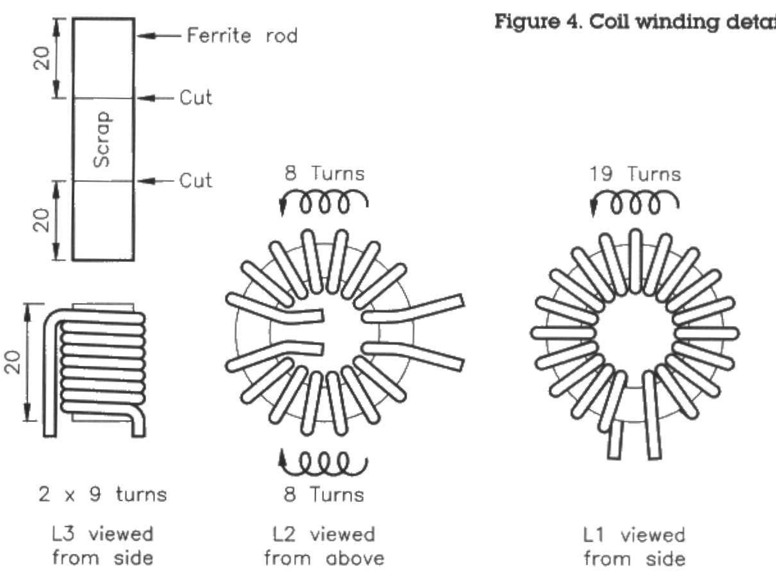
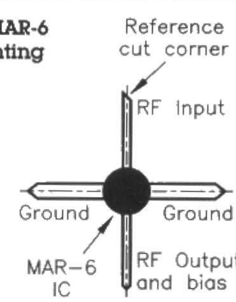


Figure 4. Coil winding details.

Figure 5. MAR-6 (IC1) mounting details.



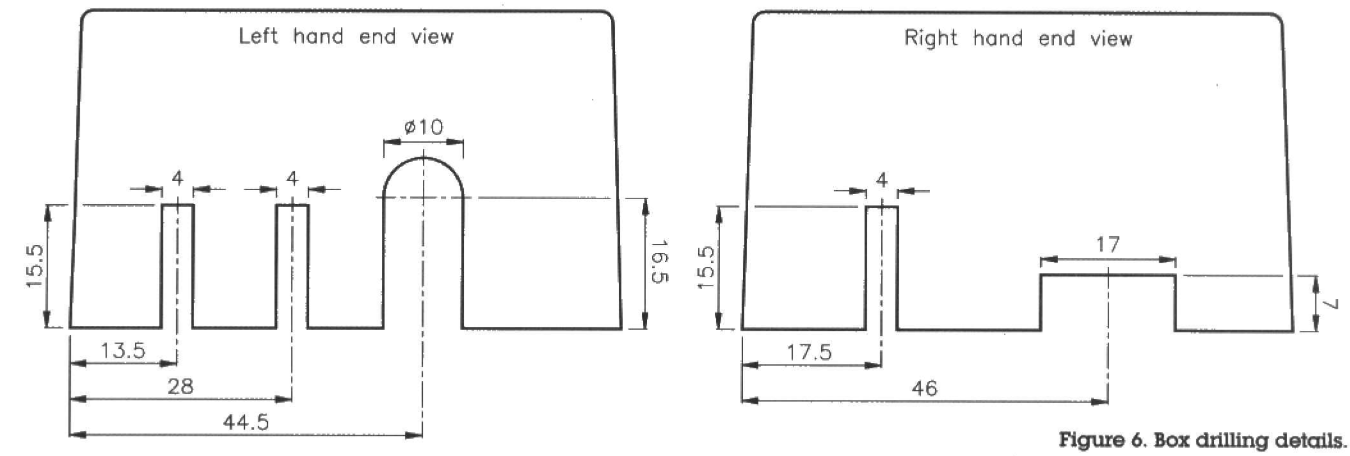


Figure 6. Box drilling details.

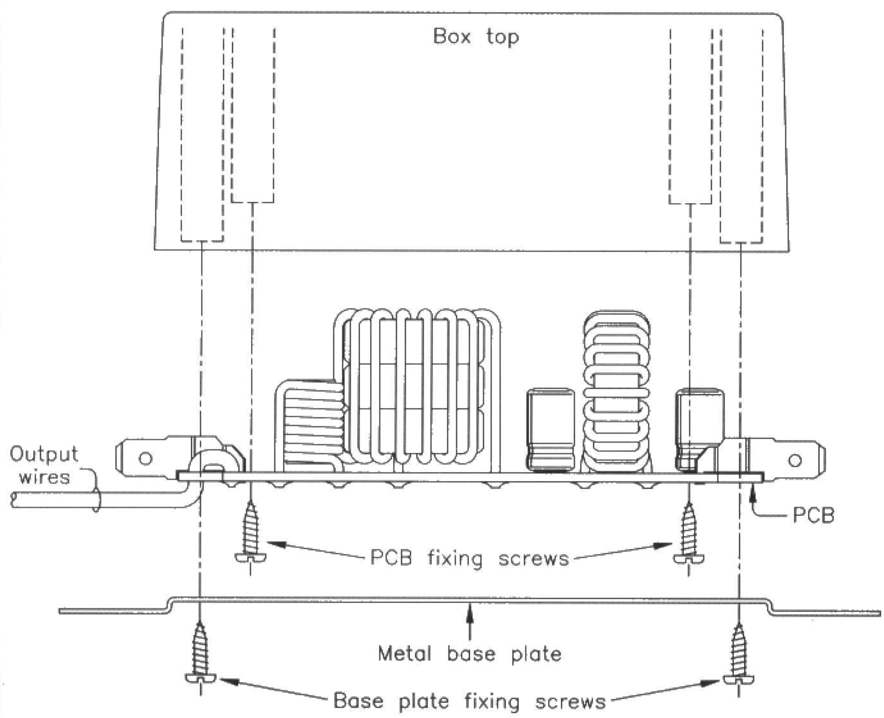


Figure 7. Exploded assembly diagram.

winding the coils, and ensure that they are wound as tightly around the cores as possible, so as to minimise resonance effects.

Be careful to correctly orientate the polarised devices, i.e. electrolytics, diodes, FET, and IC1 – refer to Figure 5. Additionally, take antistatic precautions when dealing with the latter two components. Fit the full length of red and black wire to the PCB, the wiring can be trimmed to the correct length and have the connectors fitted prior to installation. Thoroughly check your work for misplaced components, solder whiskers, bridges and dry joints. Finally, clean all the excess flux off the PCB using a suitable solvent. The supplied matrix board with the box will not be required. To initially set up the aerial amplifier, the dust iron cores of L5 and L8 should be set flush with the tops of the formers (use a straight-edge to confirm this), then L5's core should be screwed in a quarter of a turn, and L8's core screwed in a half turn. Use a non-metallic core adjuster tool (e.g., BR48C) for this, since there is a risk

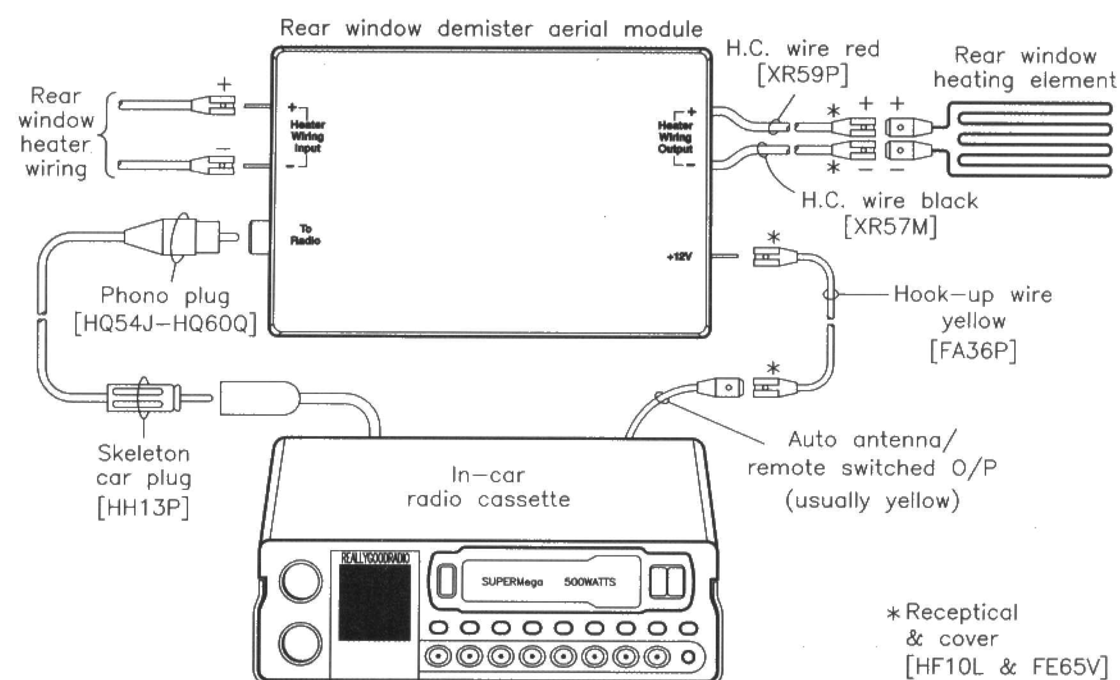


Figure 8. Wiring diagram.

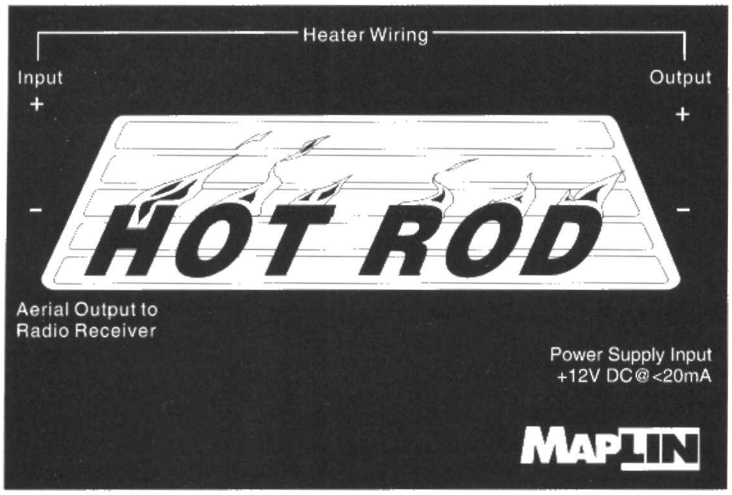


Figure 9. Front panel label.

of cracking the dust iron cores if a metal implement is used. Fine tuning can be done to optimise the reception strength once the unit is wired into the car and the radio is turned on.

Case Construction

Refer to Figure 6 for the box drilling details, and Figure 7 for the assembly diagram. The PCB is placed into the box component side facing inwards. The PCB is secured in place using the four screws supplied with the box, and then the metal back-plate is put on and secured with four screws. There is a plastic protective film on this back-plate, which can be removed prior to vehicle installation.

Installation

Check the maximum rear window demister heating element current consumption for your vehicle, more than 15A is not recommended for periods longer than 30 minutes (50% rated at 15A, 30 minutes in each hour maximum); your vehicle will use more petrol to produce the power to run the heating element, so fit a timer – but that's another project for a future issue of *Electronics!*

Refer to Figure 8 for the wiring details. First, find a suitable position for the amplifier, which would be underneath the rear parcel shelf in saloons, or somewhere within the tailgate cavity for hatchbacks and estates. Ensure that the unit is mounted out of the way of any possible moisture ingress, since the specified casing is not waterproof – make sure that the boot seals on the vehicle do not leak! The front panel label shown in Figure 9 should be applied (observe its orientation) having cleaned the box beforehand.

Take note of the vehicle heater wiring, and identify the plus (+) and minus (–) terminals; check that the minus (–) terminal is not bonded down to the bodywork. It may be possible to pull back the heater supply wiring, to connect directly to the amplifiers PCB terminals; if not, extension leads will have to be made. Trim the red and black wires to the heater element to the correct length, and fit the terminals and insulators.

Safety Warning

Ensure that where wiring passes through holes in bulkheads, etc., rubber grommets are used to prevent the wires from chafing. Double-check all your wiring after installation to ensure the security and correctness of the connections. Remember that a car battery is capable of providing enormous short-circuit currents (300A or more!), so take the utmost care to avoid short circuits, which could lead to fires or damage to the vehicle's wiring. Remove all metal jewellery, particularly rings, watches and bracelets, that could come into contact with the vehicle electrics, and ensure that the vehicle's ignition is switched OFF before starting work.

REAR WINDOW DEMISTER AERIAL PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (Unless specified)			
R1	47k	1	(M47K)
R2	100Ω	1	(M100R)
R3	220Ω	1	(M220R)
R4	390Ω	1	(M390R)
CAPACITORS			
C1,3,7,8,12,14,16	100nF 50V Ceramic Disc	7	(BX03D)
C2,4	220µF 35V Radial Electrolytic	2	(JL22Y)
C5,6	1nF Ceramic Disc	2	(WX68Y)
C9,11	10pF Ceramic Disc	2	(WX44X)
C10	1p8F Ceramic Disc	1	(WX35Q)
C13	47µF 25V Radial Electrolytic	1	(FF08J)
C15	1µF 100V Radial Electrolytic	1	(FF01B)
SEMICONDUCTORS			
D1,2	1N4148	2	(QL80B)
ZD1	BZY88C 18V Zener	1	(QH20W)
TR1	BF244A	1	(QF16S)
IC1	MAR-6	1	(DK24B)
MISCELLANEOUS			
L1,2,3,4		(See Text)	
L5	0µ45H RF Coil	1	(UF69A)
L6,9	1mH RF Choke	2	(WH47B)
L7	47µH RF Choke	1	(WH39N)
L8	0µ114H RF Coil	1	(UF64U)
T1-5	Horizontal PCB Mounting Blades	5	(GV13P)
SK1	PCB Mounting Phono Socket	1	(HF99H)
	Box with Base and Matrix Board Type TB15	1	(YU46A)
	Ferrite Rod Aerial Type 810	1	(YG20W)
	FX 4054 Ferrite Torroid	4	(JR84F)
	Push-on Lucar Blades	1 Pkt	(HF11M)
	Push-on Blade Covers	1 Pkt	(FE66W)

Push-on Lucar Receptacle	1 Pkt	(HF10L)
Push-on Receptacle Covers	1 Pkt	(FE65V)
1·6mm 16swg Enamelled Copper Wire	1reel	(BL24B)
High Current Wire Red	2m	(XR59P)
High Current Wire Black	2m	(XR57M)
Front Panel Label	1	(90067)
PCB	1	(90066)
Instruction Leaflet	1	(XV77J)
Constructors' Guide	1	(XH79L)

The Maplin 'Get-You-Working' Service is available for this project, see Constructors' Guide or current Maplin Catalogue for details.

The above items are available as a kit, which offers a saving over buying the parts separately.

Order As 90065 (Rear Window Demister Aerial)

Price £24.99 A1

Please Note: Where 'package' quantities are stated in the Parts List (e.g., packet, strip, reel, etc.), the exact quantity required to build the project will be supplied in the kit.

The following new items (which are included in the kit) are also available separately, but are not shown in the 1996 Maplin Catalogue

Horizontal PCB Mounting Blades
Order As GV13P Price 9p

Ferrite Rod Type 810 **Order As YG20W Price 59p**

Rear Window Demister Aerial PCB
Order As 90066 Price £2.99

Rear Window Demister Aerial Front Panel Label
Order As 90067 Price £2.29

What's On?

Conference Voices Environmental Concerns

Environmental decisions are becoming a key issue in designing electronic and electrical products, driven by a changing European legal framework, increased competitiveness and the need for innovation.

With management and disposal of electronic waste now a priority within the European Union, and moves towards manufacturer responsibility, particularly in Germany, France and Sweden, green issues are set to stay on the engineers' design agenda.

On November 1, a seminar and workshops has been organised by The Centre for Sustainable Design at the Royal Horticultural Halls, titled 'Environmental Issues in the Design of Electronic and Electrical Products'. Speakers will include Douglas Robinson from the DTI Environmental Unit, who presents the background to eco-issues in the electronics and electrical products industry. This will be followed by a presentation on the changing legal framework by Andrew Waite of Berwin Leighton, while Cheryl Rodgers of the University of Portsmouth, will give an overview of corporate approaches to present a paper on designing in eco-efficiency and Ray Mann, CEO of the MANN Organisation and founder of EEMRG (Electronic Equipment Manufacturers Recycling Group), will present a paper on the design issues surrounding electronics recycling. Finally Steve Bushnell, environmental manager at IBM UK, will present a paper on the company's approach to the design environment.

Contact: The Centre for Sustainable Design, Tel: (01252) 732229.

ISDN in the Global Spotlight

The world's fastest-growing tele-communications technology – ISDN (integrated services digital network) – will be at the heart of the biggest international collaboration ever seen by the world's telecommunications industry. From 28 to 30 November, an estimated 120 organisations in over 30 countries will be bringing ISDN into the international spotlight, in a three-day showcase known as Global '95, designed to promote international connectivity for ISDN-based solutions.

The three-day event will be a large distributed trade show in multiple locations around the world, all linked to each other via ISDN. At locations in each participating country, major ISDN equipment and service providers – including industry leaders such as Alcatel, AVM Bellcore, Cisco Systems, IBM, Intel, KNX, MCI, Motorola, Olivetti, Racal Datacom, Siemens Nixdorf, Spider Systems, 3Com, and all European telecommunications operators – will be participating in exhibitions or conferences, and demonstrating new and exciting applications that take advantage of the power of ISDN, illustrating the benefits of ISDN.

In the United Kingdom, BT will host three events – a 'Global Village' at the TMA (Telecommunications Managers Association) annual conference in Brighton; a business sector-based exhibition at the G-Mex Centre in Manchester; and a high-level political debate at the Queen Elizabeth II Conference Centre in London.

Contact: BT, Tel: (0171) 356 5369.

IBM UK Announces 'IBM on Saturday' Shows

IBM is staging a series of special weekend events during October and November, showing PC enthusiasts how they can convert their quiet, unassuming PC into an all-singing, all-dancing multimedia machine. Designed for young professionals aged between 25 and 35, the half-day shows include guidance on how to surf the net, how to drive the PC by voice, and how to exploit its full multimedia potential.

Attenders receive an array of multimedia kit, including CD-ROM player, speakers and sound-blaster card. They also get IBM's OS/2 WARP, a Rough Guide to the Internet, and some of the latest CD games, all of which would retail at around £450 in the High Street. Not only do attenders receive the full pack for just £130, they also get free guidance on how to use it. Each show lasts half a day, and there are shows in London, Manchester and Glasgow.

Contact: IBM, Tel: (0171) 202 3570.

Science Museum Launches Superhighway UK Tour

Over half a million people had the chance to discover the future of global communications when they visited the Science Museum in London between April and September. The Museum's Information Superhighway exhibition is now set to open the eyes of audiences all over the country, as it heads off on an eighteen-month tour.

Completely hands-on, this screen-based exhibition explains computer networks and the Internet. Looking to the future, it asks whether the Information Superhighway will transform our lives through developments such as virtual surgery, and the arrival of the global office. Visitors can sample interactive television, browse at an on-line supermarket, and find out about home banking.

Contact: Science Museum, Tel: (0171) 938 8192.

DIARY DATES

Every possible effort has been made to ensure that the information presented here is correct prior to publication. To avoid disappointment due to late changes or amendments, please contact event organisations to confirm details.

31 October to 2 November. Voice '95, Olympia 2, London. Tel: (01244) 378 888.
1 November. Environmental issues in the design of electronic and electrical, Royal Horticultural Halls, London, Tel: (01252) 732229.
4 and 5 November. IBM on Saturday Shows, IBM South Bank, London. Tel: (0171) 202 3570.
8 to 11 November. Apple Expo, Olympia, London. Tel: (0171) 388 2430.
7 to 9 November. Software Development Exhibition, NEC, Birmingham. Tel: (0181) 742 2828.
10 to 12 November. Design & Technology Education Exhibition, NEC, Birmingham. Tel: (01425) 272711.
11 and 12 November. IBM on Saturday Shows, UMIST, Manchester. Tel: (0171) 202 3570.
13 November. DX Expedition, Vincent Denecker, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.
18 November. RGSB Headquarters Open Day, Potters Bar. Tel: (01707) 659015.
21 November. Weather Satellites – an illustrated talk from Mark Clarke, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.
22 November. Construction Contest, Lincoln Short Wave Club, Lincoln. Tel: (01427) 788 356.
27 November. Balun and Matching, David Yates, G3PDQ, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.
28 to 30 November. Computer Graphics Expo, Wembley Centre, London. Tel: (0181) 995 3632.
7 to 11 December. Computer Shopper Show, Wembley Centre, London. Tel: (0181) 742 2828.
11 December. Open Evening, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.
19 December. Christmas Social, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.
25 December. Christmas Greeting on Air, 11·00am 145·275MHz, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.
8 January. Winter Social, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.
16 January. Annual General Meeting, Bury St. Edmunds Amateur Radio Society, Suffolk. Tel: (01284) 764804.
20 January to 25 March. Science Museum Superhighway UK Tour National Museum of Wales, Cardiff. Tel: (0171) 938 8192.
22 January. Projects, Grouses, Problems and Solutions, Stratford-upon-Avon and District Radio Society. Tel: (01789) 295257.

Please send details of events for inclusion in 'Diary Dates' to: News Editor, *Electronics – The Maplin Magazine*, P.O. Box 3, Rayleigh, Essex SS6 8LR.

NEXT issue

There are more terrific projects and features heading your way soon in next month's super issue of *Electronics – The Maplin Magazine*, including:

PROJECTS

The January 1996 issue of *Electronics* contains another intriguing variety of useful, educative and fun to build projects, comprising:

GPS SYSTEM

The Global Positioning System is a recently introduced and popular, though expensive, gadget on the marketplace, which utilises signals from satellites in space to pinpoint your precise location on Earth. This project is an inexpensive way of producing such a system for yourself, and finding out how they work into the bargain!

LIGHT SEQUENCER SOUND-TO-LIGHT ADAPTOR

A convenient add-on unit for December 1994's Christmas Tree Lights Sequencer project. This enables the system to flash the lights in response to noise, meaning that the project can be used not only to twinkle your Christmas tree's lights during the festive season, but also to flash disco lights at parties held during the rest of the year!

Z80 SERIAL CARD AND DEVELOPMENT SYSTEM

An ideal project for those wishing to gain a good understanding of how the widely used Z80 microprocessor operates, and how to use and program it to do what you want. This system is a serial interface and monitor for the existing Maplin Z80 CPU Module, which allows programs to be developed on a PC running Windows, before being downloaded to the module.

DIGITAL MULTIMETER

This project describes a high-quality, accurate and up-to-date design of digital multimeter kit, featuring automatic or manual range selection, which is just the ticket for constructors and experimenters who prefer the satisfaction of building their own test-gear instruments, rather than having to place their faith in a ready made, off-the-shelf item.

FEATURES

An absorbing selection of special features and series are planned for this issue, including Biometric Recognition Technology by Frank Booty. Digital VHS Explained by Reg Miles. HIPPARCOS by Douglas Clarkson. Lightning Spikes and Surges by Ian Poole. Electromagnetic Compatibility (EMC) by John Woodgate. There are also the continuing parts of Practical Guide to Modern Digital ICs by Ray Marston, and The Internet by Stephen Waddington. Make a New Year Resolution not to miss out on this issue!

All this, plus all your favourite regulars as well!

ELECTRONICS – THE MAPLIN MAGAZINE

BRITAIN'S BEST SELLING ELECTRONICS MAGAZINE

Light-sensitive Battery Saver

by J. M. Woodgate B.Sc.(Eng.), C.Eng., M.I.E.E., M.A.E.S., F.Inst.S.C.E.

If you happen to have a light-sensitive battery, and it gets into danger, will this circuit save it? No, but it is useful! Some battery-operated equipment just stays on unless you switch it off, while other 'battery savers' automatically switch off just as you want to use the equipment again. These timed savers can be a bit complicated to include in home-designed circuits as well. The battery saver described here is an entirely bolt-on unit. It requires no interference with the rest of the circuitry of the equipment, beyond picking up a supply of 3·5mA (maximum) at 5 to 12V, and has a quiescent current drain of the order of 30µA, which should not significantly reduce battery life.

It works by sensing the ambient light level. When this is too low, either because you have put the unit back in its box and closed the lid, or because the workroom or shack is dark, the saver sounds a bleeper and flashes an LED. This should call your attention to the situation, and you can ensure that the unit is properly switched off. It is quite possible to extend either the LED or the sounder wiring to a remote point, if you want to. Another possibility is to rig a 'baby alarm' type system with the microphone in your workroom, so that you can hear if anything bleeps. If you really want to break into the circuitry of the equipment so as to arrange an automatic switch-off, then the circuit will do that as well, in principle. However, so much depends on the design of the equipment's own power circuits, that only a general guide can be given in this case.

Referring to the circuit diagram shown in Figure 1, two gates of the quad 2-input NAND Schmitt 4093BE (QW53H) provide square-wave oscillators, one at about 2·5kHz and one at about 5Hz. The higher frequency oscillator should be adjusted, by selecting the appropriate value of C2, to match the resonance frequency of the piezo transducer or sounder. This will greatly increase the sound output. Both oscillator frequencies depend on the supply voltage, as well as the values of C1 and C2. With a 9V supply, the frequencies mentioned above were obtained with the capacitor values shown.

To keep the quiescent current low, both oscillators are stopped when the collector voltage of the MEL12 photo-Darlington transistor Q1 (HQ61R) is low. When the light level falls, the oscillators run and their combined output is applied both to the LED, which simply flashes, and to the piezo-electric element BZ1, which can either be simply a disc, such as YU85G, or a sounder assembly, such as FM59P. The latter requires C2 to be reduced to 5·6nF at 9V. The LED is a low-current type, such as CJ56L or CJ58N (3mm green and red, respectively), and to get a bright light, it is run at a peak current of 4mA, with approximately 50% on-time, so that the average current is the recommended 2mA.

The piezo element is driven in push-pull between the outputs of the remaining two gates, which gives a welcome 6dB increase in sound level (four times 'power', but since the piezo element is a capacitor, talk of power is misguided). To get the maximum sound output from an unmounted disc, it must be rigidly fixed to something which acts as a 'sounding board', i.e. it vibrates in sympathy with the disc. Something too rigid and massive will not work. Sounder assemblies include a Helmholtz resonator, an air volume with a small hole to the outside air, which resonates at the same frequency as the element and amplifies the sound output. This is the same resonance effect as you get by blowing across the neck of a bottle, and although it is named after the German physicist Helmholtz, the Romans and Greeks embedded earthenware or glass 'bottles' in the walls of their theatres, as resonators to improve the acoustics, 2,000 years ago. No microphones and amplifiers in those days! To add an automatic switch-off, the gate previously used to drive the piezo element only, is used to control instead, a series-pass transistor in the power line of the equipment, as shown, in principle, in Figure 2.

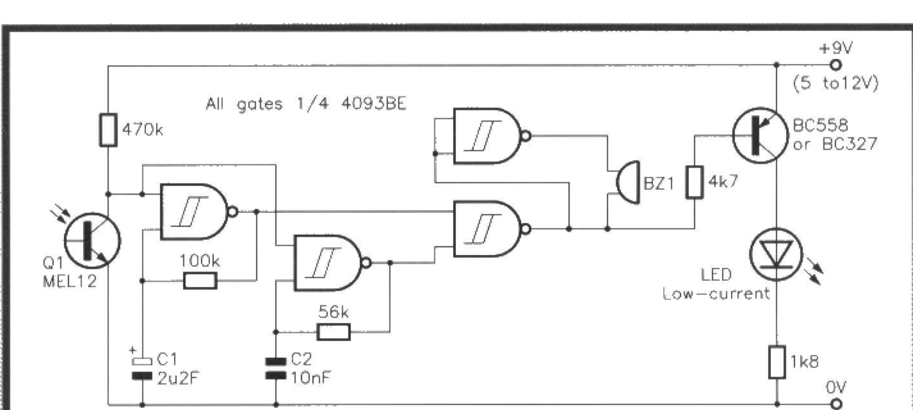


Figure 1. Basic light-sensitive battery saver circuit. Make sure that the photo-Darlington cannot 'see' the LED!

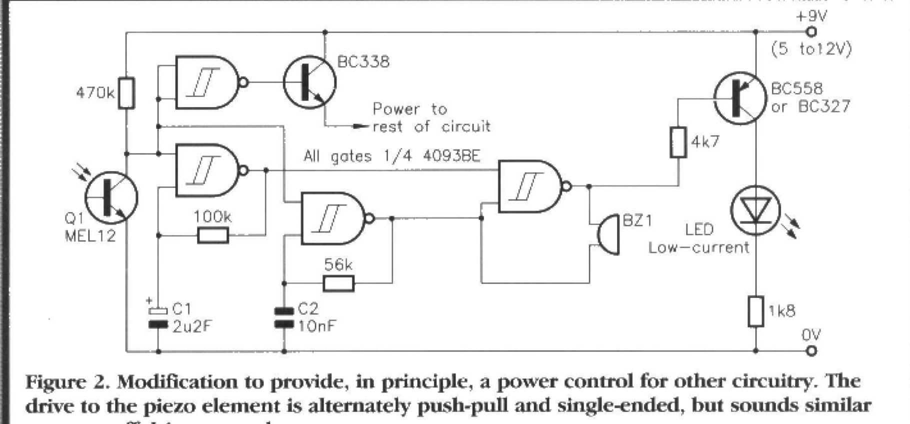


Figure 2. Modification to provide, in principle, a power control for other circuitry. The drive to the piezo element is alternately push-pull and single-ended, but sounds similar to an on-off driven sounder.

The INTERNET PART:1

Getting Online....

You've read all about what's out there in Cyberspace, but have you boarded the information superhighway? Do not be daunted. In Part 1 of this series on the Internet, Stephen Waddington takes a look at what its all about.

What is the Internet?

The Internet is a global network made up of smaller individual networks, each linked together through the telephone system – see Photo 1. There is a body called the Commercial Internet Exchange which is trying to administer things, but no one owns the Internet, no one censors it, and it is self-financing.

How Many People are out There?

It is possible to guess at the number of networks connected together, but impossible to gauge how many users each of these individual networks serve. Present estimates based on the numbers of subscribers hooked up to Internet Service Providers, puts the figure at around 30 million, with a growth rate of 10% per month. This means that by the year 2010, everyone will have a connection, although in practice, this is unlikely, since many people on the planet are unable to afford the hardware required to secure a connection.

Photo 1. The Internet is a sprawl of networks. Here, AT&T install under-sea fibre-optic cable, to form part of the AT&T transatlantic network, able to carry more than one million telephone conversations, or a mix of data and video – ideal fodder for the Internet.

Photo 2. Example e-mail message, produced using AMEOL the Off Line Reader for CIX (CIXMAIL.CLP).

What Can I Get Out of It?

Without a radio receiver, it is impossible to realise the variety of radio stations across the world. Equipped with a broadband receiver, it is possible to tune into services varying in format from the World Service to Chat Shows, from regional broadcasts to national rolling news services. This is a little like the Internet. There is a plethora of services around the world linked by computer networks, and like radio chat shows, plenty of opportunity for individuals to participate.

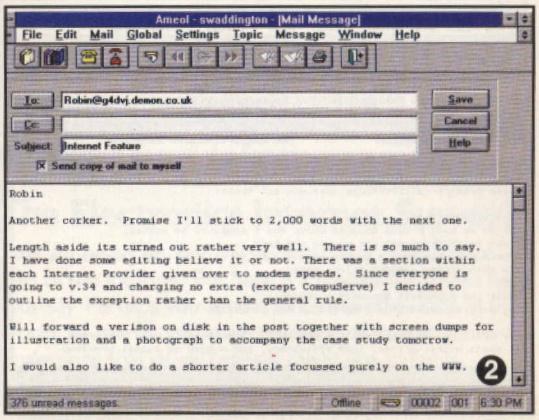
With a modem connection to your PC, you can link in to this international network of computers around the world. This is usually done through a Service Provider, who will give you a unique address. Simpler ones consist of a string of words, such as swaddington@cix.compulink.co.uk. More complex ones consist of a string of numbers, such as 100611,245@compuserve.com.

Once you've got an e-mail address, you can communicate with the 30 million other people online, and exchange the electronic version of mail, called e-mail. Your e-mail address is attached to a remote mailbox – usually an area on a hard disk or server held by your Network Provider – which you must interrogate regularly to pick any new e-mail. An example mail message is shown in Photo 2, together with a mail manager available as part of a software suite called AMEOL, from the Internet Provider, CIX. I usually compile e-mails on a daily basis, and go online in the evening to despatch out-going messages and retrieve any in-coming ones.

The good news is that this process is inexpensive, and is literally instantaneous. A page of text can be sent to Hong Kong in seconds for the price of a local phone call. Compare this with a fax or letter: a one page fax takes at least a minute, and a letter takes days. There are also other benefits. For example, a colleague and I have been preparing a research paper over the last two months, for presentation in the USA in the Autumn. He spends the majority of his time in Asia Pacific, while I'm based in the UK and occasionally venture to continental Europe. Yet despite this, we have been able to send the document backwards and forwards, with each of us making amendments on screen.

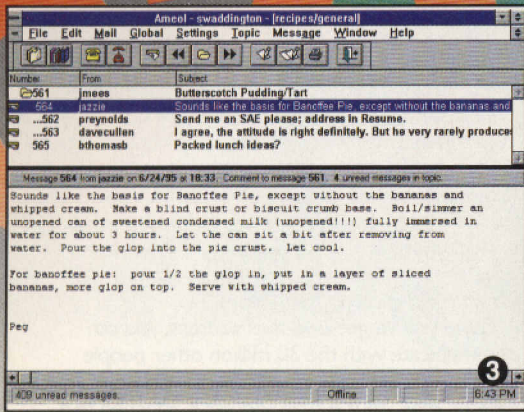
Many Service Providers operate conferences. These are based on a topic such as electronics, viruses or CAD, and are often divided up into several sub-topic areas. It is possible to join a conference at any time, and become involved in discussions by posting and exchanging e-mails within the conference area. An extract from the recipe conference on CIX is shown in Photo 3. Conferences often contain file areas relevant to the topic. Here, public domain software can be downloaded and exchanged with other users.

Newsgroups are an extension of the conferences, as illustrated in Photo 4, available from Usenet, the global Internet news service. Because Usenet is available on the Internet, newsgroups have global access, with the majority of Service Providers offering access. Once you join a conference or newsgroup, you'll find anything from ten to a few hundred messages posted daily. And if you can not find something of interest, you must have



pretty bizarre hobbies, since there are around 6,000 newsgroups in existence, each with around five or more sub-groups.

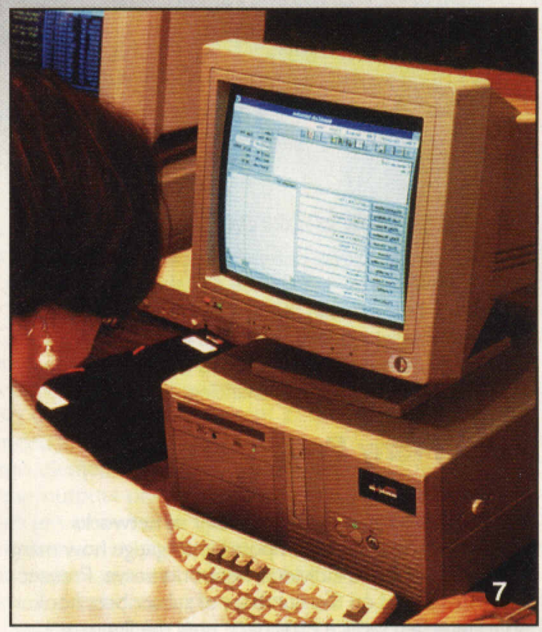
FTP is held over from the days when computing was all mainframe-based, and stands for File Transfer Protocol. It is simply a method of accessing and transferring files



from a host machine to a client. Numerous networks connected to the Internet have FTP sites. The easiest way of accessing these is by using a World Wide Web (WWW) browser, as shown in Photo 5.

Similar to FTP, but slightly more advanced, is GOPHER which again, can be accessed using a Web Browser. Like FTP, it is text based, but uses menus to help you find your way around. Many universities and commercial networks have extensive sites which you can explore at will. However, remember that both FTP and GOPHER sites provide access for free, and get little benefit from doing so – do not abuse the services provided.

The World Wide Web is where the real fun is to be found. To access this, you need full dial-up Internet access from a dedicated Service Provider, together with a WWW browser. A Web site is a collection of linked multimedia documents which you can browse, and download. This is a rapidly expanding area of the Internet, and is the most exciting. Text is combined with graphics and sound in over 25,000 sites around the world.



How Do I Get a Piece of the Action?

You need a modem as shown in Photo 6, a computer as shown in Photo 7 and an account with a Service Provider that will provide you with a gateway to the Internet. Communications software does not need a heavy-duty machine. A 4M-byte PC or Apple Mac is almost overkill, and you needn't be restricted to these platforms. Electronic communications will work equally well with machines such as the Acorn Archimedes or Atari, providing you can secure a modem connection and the appropriate software for online connection.

Most PC-based communications software uses a Windows front-end. Photo 8 shows two packages available from CIX and CompuServe. But that does not mean it is impossible to secure an Internet connection on a DOS-based machine. A number of Service Providers, such as Delphi, offer DOS software. When looking at different services, it is worth asking if an Off Line Reader (OLR) is available. Packages such as

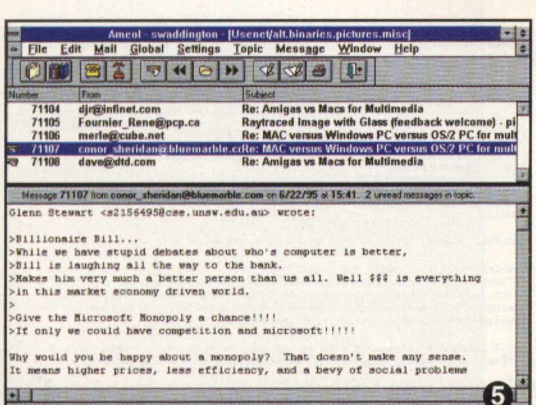
Photo 3. Extract from the recipe conference on CIX (CIXRECI.CLP).

Photo 4. World Wide Web browser called Netscape, available from PIPEX as part of the PIPEX Dial communications package (NETSCAPE.CLP).

Photo 5. A Newsgroup on Usenet, the global Internet conferencing system (CIXUNET.CLP).

Photo 6. Modem for use with a personal computer.

Photo 7. Personal computer with communications software (requires an account with a Service Provider).



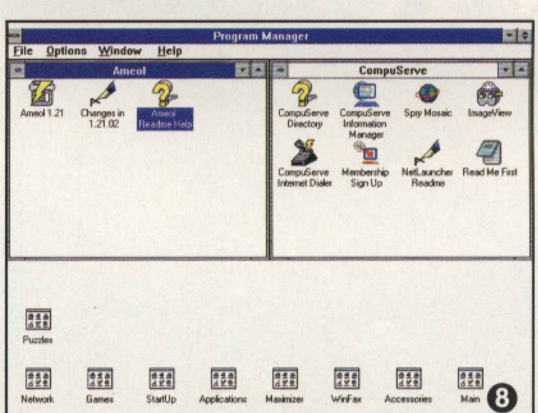


Photo 8. Internet Providers are increasingly producing their own Windows front end communications software. Here, two packages available from CIX and CompuServe are shown (WINICONS.CLP).

AMEOL for CIX, as shown in Photo 2, keeps the cost of your telephone bill down, by automating the process of logging on to CIX. AMEOL allows you to prepare and queue messages before logging onto CIX to download queued messages, and receive any which are waiting.

What Do I Get From a Network Provider?

Commercial Network Providers have their own information services, in addition to links into the wider world of the Internet. While a Provider's own services are interesting, a connection to the wider world of the Internet is the key.

Increasingly, Internet Service Providers are offering software packages that combine a mail service, with a WWW Browser for accessing FTP, GOPHER and WWW sites. These certainly make life much easier than attempting to get two shareware packages to communicate with each other, let alone access your Service Providers network. Beware of Providers who offer text-based WWW browsers. The multimedia content of the WWW is what makes it unique. Ignoring these features somewhat defeats the object.

The scope of a Providers' services can vary considerably. For instance, CompuServe, who has 3 million subscribers around the world, provides an online shopping mall, online access to telephone directories, local weather satellite picture and AA road maps for route planning. Meanwhile, CIX is far more technical, operating numerous technical newsgroups, but very few useful commercial services.

Glossary of Terms

Address: Can be either an address of a place on the Internet or the address of a person.

Archie: A powerful – although at times unfriendly – Internet search tool.

BBS: Bulletin Board System, a computer equivalent of a public notice board.

Dial-up: Connecting to another computer via the telephone lines.

E-mail: Electronic Mail – messages sent over the Internet. Could be about anything from purely personal letters, to business correspondence, to mailing lists.

FTP: File Transfer Protocol – the software and also the standard required to swap data and programs between sites on the Internet.

Gateway: A computer or system that connects you to a new or other part of a system.

Gopher: An Internet tool that lets you search for files, graphics and more, using on-screen menus.

Mailing list: A list of addresses of people who want to receive the equivalent of an electronic newsletter on a given subject by e-mail.

Modem: MOdulator/DEModulator, a device that connects the computer to the phone line and allows the computer to transmit and receive data to and from other modems.

Newsgroups: Conferences on the Usenet organised into several groups, including comp (computers), soc (society), and alt (alternative). Browsing these is the first step to getting to know the Internet.

PPP: Point to Point Protocol – a similar system to SLIP for modem users.

Protocol: An agreed standard for communication between two computers.

SLIP : Serial Line Internet Protocol – standard to allow home users with modems to access the Internet.

TCP/IP: Transmission Control Protocol/Internetworking Protocol. The set of Internetworking standards that allows computers to exchange messages and share resources across a network which the Internet is based on.

World Wide Web–WWW: Graphical system developed for the Internet. Virtual links between WWW pages allow easy access to other WWW sites.

What Will it Cost?

There are potentially three cost factors, a set-up cost, an online subscription cost, and a telephone line cost. The set-up cost is charged by the Service Provider when you are initially connected online. This is often avoidable through special deals which many of the Service Providers regularly operate. Subscription costs vary, depending on the type of service which you want to purchase. Some subscribers will pay as little as £6.00 per month, purely to send e-mail. Others which provide added value service or Internet access are more costly.

The telephone line cost is the surcharge which your Telecommunications Provider, such as BT or Mercury, charges for the use of the telephone line. Since the majority of Internet Service Providers lease national and international high-speed telephone or ISDN lines from carriers such as BT or AT&T, this is often restricted to the cost of a local call. You dial into a local server, and any onward connection is provided by the Internet Provider.

Many Internet Providers are now linking into local cable networks. In London for instance, at the time of going to press, five Internet Providers were linked into the Videotron network. This means that individuals who subscribe to Videotron can have free connection to an Internet Provider between 7·00pm and 7·00am hours.

Most Internet Providers tend to confine servers to their local country. This means that if you travel abroad, you have to pay for an international call to retrieve your e-mail or dial-in to Internet services. There are exceptions. Companies such as CompuServe, that provide commercial services on an international basis, have local servers based across the world. By changing the dial-in number on your communications software, you can access your mail and other services as normal.

Getting Help?

If you run into difficulties, people who use the Internet regularly are usually the best source of assistance. You can even e-mail them, providing you are already online. Do look at the support packages offered by Service Providers, and again, it is always good to find a user who has experience with the Service Provider you are examining. Service Providers who offer round-the-clock telephone support are little more than useless if the helplines are constantly engaged.

What About the Future?

Experts are divided on the future of the Internet. Although prices are falling, personal computers are still expensive. To equip yourself with the hardware and software to go online from scratch could cost up to £1,000, which is out of the price bracket of consumers.

There are also the social barriers which must be broken down. If Internet connectivity is going to continue to grow at 10% per year, as forecast at the beginning of this article, then people are going to have to break many of their existing habits. Will people want to go shopping via computer, or read the Sunday papers on screen?

The Electronics Internet Survey?

Later in the series, we will be examining professional uses of the Internet. But here is a chance for you to have your say. Perhaps you send mail to the other side of the World, or maybe you are a member of an electronics conference that other readers might like to know about. Please e-mail Stephen Waddington direct, at **swaddington@cix.co.uk** with details of the Internet.

@Internet

Nothing about the Internet is as exciting as the first time you get online. The thrill of realising you are connected to a computer which is located at the farthest corner of the world only happens the first time. Once you've surfed a little and experienced the perils and pitfalls of world wide web browsing, and once you've downloaded a couple of utilities from an archive in the States, the Internet is nowhere near as daunting as it seemed before you decided to take the plunge.

But it's the plunge which is the big thing. Technically, you've got to get all the software and utilities your computer needs to join up gathered together before you even access your local point of presence (POP). And even when you've got the software, you've got to understand (or at least have a jargon-English phrase-book to help you translate) all the terms which are used by surfers all over the world.

Even a little phrase, such as *point of presence*, is confusing enough when you've not dipped your toe into the Internet waters before. Your point of presence is, to all intents, the dial-up number of the Internet service provider you opt to join. For your monthly fee, you generally have access to your provider's Internet service. Then, your computer dials the number of the service provider, via your modem, and logs onto the provider's computer. The number dialled denotes the point of presence. It is best to have a point of presence as close as possible to you, such that the 'phone charge you knock up on your 'phone bill, is as low as possible.

Put another way round, you don't want a point of presence outside your local charge area. Your 'phone bills are going to be high enough (expect yourself to be logged on for hours on end – the Internet's pretty fascinating, and it's just amazing how quickly the time flies), without making them higher still because of long-distance call charges. Fortunately, most Internet providers now have points of presence around the country (at least one offers points of presence sufficiently spaced so that nearly all the population lies within a local call distance). However, before you sign up with any Internet provider, check the distance to the closest point of presence. You might find that the cheapest service in direct terms isn't necessarily the cheapest once you've included call charges.

Local Demon Access Available Nationwide

Demon Internet is to provide local-call access to the Internet for the whole of the UK. Demon Internet is the first Internet Service Provider in the UK to be able to announce local call access for the whole of the UK. 100% coverage will roll out from the end of October, allowing all UK customers to enjoy connectivity at the BT local call rate. Simultaneously, all the Demon Internet numbers will change, so that they become suffixed with '666', making them instantly recognisable.

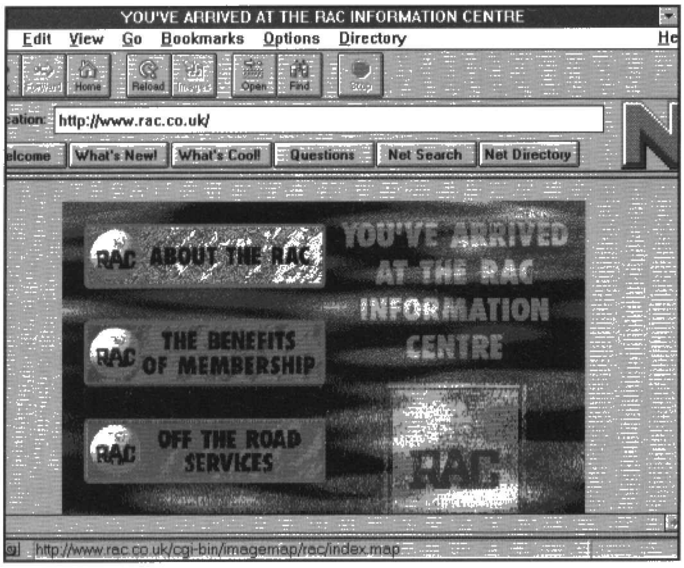
So, for example, number charge group 01469 will have the Demon number 01469 469666; and number charge group 0161 will have the Demon number 0161 3859666.

Demon Internet will no longer be referring to tPoPs (traditional Points of Presence) and vPoPs (virtual Points of Presence). Instead, ROMPs (Regionally Organised Modem Pools) is the new buzzword. There are 3 ROMPs, covering Central England and Southern Scotland; Southern England and Northern Scotland; and Ireland. Demon Internet's dial-up service costs £12.50+VAT, plus a one-off start-up fee, of £10 plus VAT per month. There are no additional online costs, and technical support is provided free.

Contact: Demon Internet, Tel: (0181) 371 1234.

Royal Automobile Club Pulls onto the Superhighway

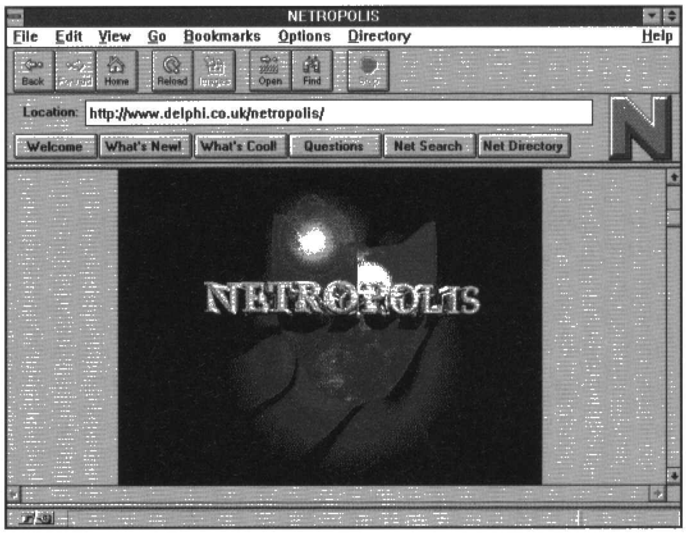
The RAC has extended its services from the highway to the superhighway, with the launch of a Web site at URL **http://www.rac.co.uk/**. Net surfers can now access information on RAC membership and member benefits. The new site will soon be developed to allow interactive comment on the latest motoring issues. RAC Database Manager, Dean Turley, is enthusiastic about the opportunities the Internet presents to the company in the UK and Europe, "The beauty of the Internet is that we can incorporate any information from any part of the organisation that we feel would benefit Internet users. With the development of an interactive site, we will be able to respond to requests from both RAC members and non-members alike."



Delphi Announce Internet Game

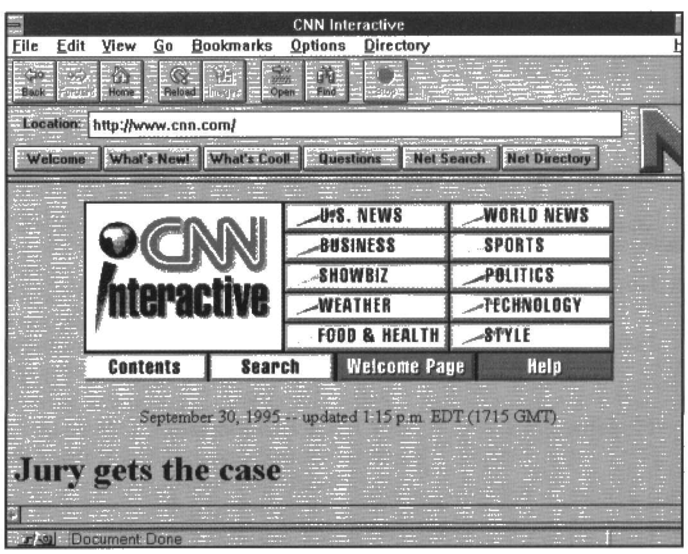
Netropolis, from Delphi, is an innovative new game for Web surfers with a Netscape browser. The game, a multi-player city-building simulator, can be accessed at URL **http://www.delphi.co.uk/netropolis/**. In Netropolis, the player registers a company name and proceeds to construct buildings within a city on the play screen. These buildings generate income, and with other players striving to build up their own property empire, the competition can get very rough, even explosive.

The object of the game, is to become the wealthiest company in Netropolis. Income is calculated hourly, and depends on the success of a player's strategy. With 24 hours of real time representing one year, certain other elements such as the age of a building, annual property taxes and overall game strategy, also affect a player's income.



CNN Launch Web-based News Service

CNN has launched an innovative, multimedia news service on the Internet at URL **http://www.cnn.com.** CNN's Web site sets itself apart from others on the Internet, as the only site with a 24-hour full-time staff reporting constantly updated news augmented by video, sound clips, still photographs and maps, as well as text. For users of the Internet, it is both a source of breaking news and a rich database. CNN's site incorporates the network's unmatched news gathering resources of 2,500 people, including nine domestic and 21 international bureaux, along with the resources of more than 600 worldwide broadcast affiliates, to bring up-to-the minute US and international news to Web users.



Another Way

For a long time, the computer has been the only entry to the Internet. This is largely historical, of course. The Internet is but a network of computers, and it seems perfectly right that to access it, you should do so through another computer, but it's not a prerequisite. Philips is about to break the mould and show how the Internet is really just another entertainment medium, by starting up a service called CD Online, which is an extension of its CD-i players. Users buy a kit from Philips, which includes a modem and required software, then access the Internet using a CD-i player coupled to a home TV as a display device. Philips has even developed a web browser to get users around the Internet.

It is a fairly natural coupling of technologies. The TV is an entertainment medium which computer manufacturers have long wanted to tap. Some home computers use the TV as a display device, but of course, the resolution and hence, picture quality, is nowhere near as good as a dedicated computer monitor. Games consoles abound, which combine the TV display with a computer style front-end, sufficient to convince mum and dad that the kids are actually getting educational benefit. And what is CD-i, but (primarily) a games console in disguise? So, a marrying of console computer technology and the Internet is, after all, a pretty logical evolutionary step. Surprising it has taken so long to get there actually, given the hype the Internet has had over the last couple of years. The service should be up and running as this issue hits the news stands, and PC and Mac versions are expected next year.

Online with the Conservative Party

Following fast on the feet of the Liberal party, The Rt Hon Dr Brian Mawhinney MP, Chairman of the Conservative Party, launched the Conservative Party's Web site at the Conservative Party Conference at the beginning of October. The party has positioned the Web site as an information resource, providing a fast, reliable and up-to-date information service. Daily press releases are available, as well as details of party policy and campaigning news. The Conservative Party URL is **http://www.conservative-party.org.uk**

CompuServe Wizards Help Members Build Web Presence

The World Wide Web need no longer be the exclusive domain of big companies and technology anoraks. CompuServe members will soon be able to claim their own spot in cyberspace, using a new service that lets even novice computer users design, build and submit their very own personal home pages on the Web. CompuServe will shortly offer members two authoring tools, the Home Page Publisher, and Publishing Wizard, that will make Web publishing easier than ever before.

The Home Page Wizard will eliminate many of the hassles associated with designing and submitting a home page, the document on the Web which is the front door to a Web site. It offers drag and drop editing, templates and helpful hints, to help design attractive, personalised home pages. It also provides the ability to add hot links that can jump to any other site on the Web, the ability to insert images, and numerous other features.

CompuServe will also provide a method of publishing photos with a Web area. Members can simply mail them to a service, which will return the image on disk to members for use on their Web page. A second tool, called Publishing Wizard, will enable completed pages to be loaded onto the Net, and will also obtain a member's personal URL **http://www.compuserve.com/home/***usemame*.

CompuServe's Home Page Wizard and Publishing Wizard software will be available free to all CompuServe members. Beta testing began in late September, and the service is expected to go live in November. As part of the US$9.95 (approximately £6.65) monthly CompuServe membership, members will be able to create home pages up to 1M-byte in size.

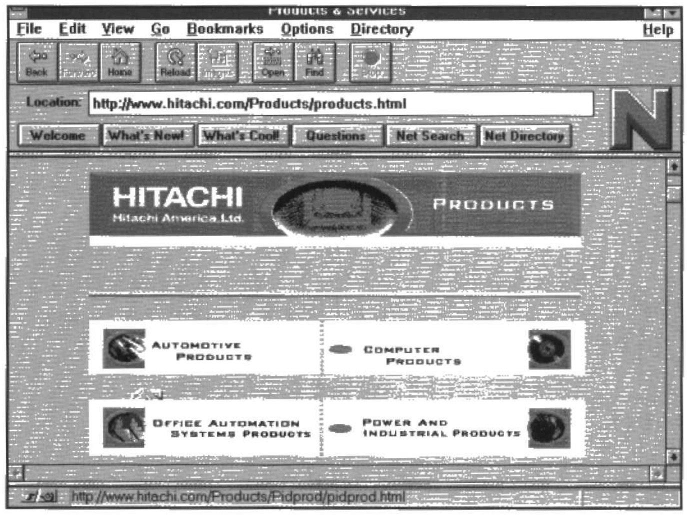
Internet-ready Modems from US Robotics

Following an agreement with Internet access provider, Unipalm PIPEX, modem manufacturer, US Robotics, will be making all its Sportster 28,000 fax/modems Internet-ready. Both external and PC internal versions of the Sportster 28,000 will be bundled with PIPEX Dial Trial, Unipalm PIPEX's personal Internet access software, and the Netscape Navigator Web browser. These modems will have free access to the Internet for one month. Sportster users who register with Unipalm PIPEX for the full PIPEX Dial service, get a further two months free access.

Contact: US Robotics, Tel: (01734) 228200.

Hitachi Gets Online

Hitachi is the latest in a stream of electronics companies to establish a presence on the Web. The company's home page at URL **http://www.hitachi.com** contains information about the company's operations, as well as extensive information about its products and services. The site also contains links to other Hitachi companies, enabling web browsers to access information on Hitachi companies around the world.

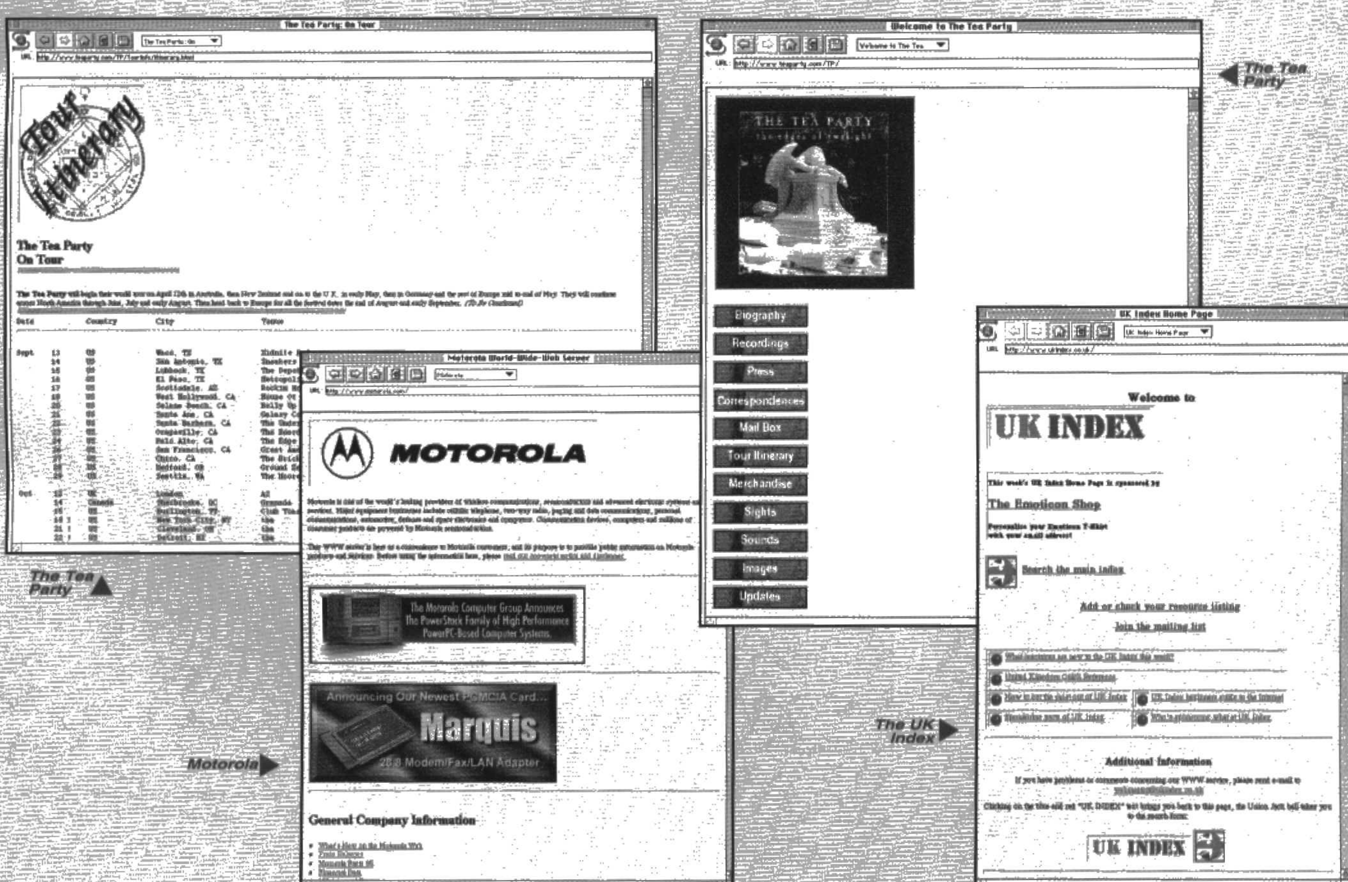


Site Survey
The month's destinations

The music scene is getting in on the Internet act, and many bands and artists have gone online with home pages. It is a useful means of getting information out to fans and followers, and the screengrabs here show a couple of pages of Canadian-based band, *The Tea Party's*, Internet site. The home page is at: **http://www.teaparty.com/TP/**

Of interest specifically to readers of *Electronics – The Maplin Magazine*, is Motorola's site at: **http://www.motorola.com/** – where you can find information regarding all the company's activities and products. Motorola is one of the key developers of the next-generation PowerPC computer products, and has previously kept a low-profile in the area, simply making the microprocessor devices for the two key computer manufacturers, Apple and IBM. However, as the site shows, Motorola is now going to be active in the computer manufacturing arena too, announcing the PowerStack range of PowerPC-based computers.

Getting your way around the world wide web is a difficult enough experience, and any attempt to make it easier can only be applauded. The UK Index at: **http://www.ukindex.co.uk/** is worth a visit, to see if any of the links it gives are of use to you. It is organised and run by Systematic Marketing, as a direct marketing tool, specifically for UK-based sites. Whether this sort of service will catch on with users is probably debatable, but this is a decent enough attempt at the task.



The Tea Party ▲

◀ The Tea Party

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